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ABSTRACT

The Sunderland Conference on the Nature and Teaching of Environmental Science/Studies in Higher Education provided an opportunity to review progress in the field and assess its state in the mid 1980s. This volume contains an edited selection of the 49 papers presented at the conference. Section A, "Nature and Philosophy," contains discussions of the educational and philosophical criteria used to shape modern environmental education. Section B, "Implementation and Practice," contains descriptions of how environmental education programs achieve their goals. The final section, "Vocational Training and Education for Life," contains papers which suggest the importance of environmental education in citizenship and career education. (CW)

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ENVIRONMENTAL SCIENCE
TEACHING AND PRACTICE

Editors:

R. Barrass, D.J. Blair, P.H. Garnham, A.O. Moscardini

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Conference Proceedings of the 3rd International Conference on the Nature and Teaching of Environmental Studies and Sciences in Higher Education, held at Sunderland Polytechnic 9-12th September 1985.

Edited by:

R. Barrass, D.J. Blair, P.H. Garnham, A.O. Moscardini

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PREFACE

Environmental Science/Studies have evolved internationally in response to such well known problems as pollution, resource depletion deprivation and poverty. These phenomena affect all countries in varying degrees irrespective of their culture, social-economic well-being and political ideology. The need to inform the public, train decision-makers, advise governments and agencies, and to change attitudes about environmental matters has become increasingly urgent. Intergovernmental reports, national recommendations, legislation, and events bear testimony to the continuing need for environmental education both globally and locally.

Considerable progress in promoting and fostering environmental awareness has already been achieved in Higher Education. After a slow entry into formal curricula, Environmental Science/Studies now offers sound education and practice in the understanding of contemporary issues and in the search for remedial solutions to the environmental problems of society. Academic studies of the environment prove to be attractive and popular with students and the public, offering exciting opportunities and scope for experiential learning and innovation. However, its dynamic state requires that theoretical tenets, philosophical foundations and practical implementation are constantly reviewed. Practitioners must also be equipped with both technical and analytic skills as well as integrative and interdisciplinary comprehension. The task of devising learning systems in both formal and informal education, to span both local and global dimensions, and to promote action-orientated strategies, leads us to believe that regular exchange of views and communication of progress are essential.

The Sunderland Conference on the Nature and Teaching of Environmental Science/Studies in Higher Education provided an opportunity to review progress and assess the state of Environmental Science/Studies in Higher Education in the mid 1980's. As the third in a series of conferences with this title organised by the Institution of Environmental Sciences (London 1979, Berne 1980), developments across a wide range of interests and practitioners were monitored. This volume contains an edited selection of the papers presented at the 1985 conference. Superficially, the interests of the speakers appear varied: some are specialised or vocationally orientated, others are general; some are couched in the language of the social sciences, others follow physical science traditions; some are philosophical, others empirical; some based as local community issues, others address global concerns. Readers are encouraged to read more than those papers directly relevant to their particular field of interest, for environmental education is a continuous and integrative process. Each contribution is part of a balanced whole and papers are presented here in an appropriate sequence.

The editorial aims have been to marry theoretical, conceptual and philosophical statements on environmental education and environmentalism with practical, technical and organisational experience. The contributions are in three sections each containing a keynote paper by an eminent, invited speaker followed by further papers illustrating or illuminating the general points of interdisciplinarity referred to in the opening statements. Finally, each section includes relevant case studies.

Thus in Section A (Nature and Philosophy) some educational and philosophical criteria shaping modern environmental education are discussed and problems of translation into practice are described by a number of academics and practitioners. Denman's paper offers some traditional and provocative judgements on how environmental education has emerged and could develop in the U.K. The philosophical ingredients of environmentalism underpinning this educational effort are dynamically outlined by O'Sullivan and developed by O'Keefe and Morphet. Rice reminds us of the inherent attractiveness of environmental education. The other keynote speaker, Furtado expands and applies some of the basic criteria of environmental education to developing countries where environmental scientists are in urgent demand as 'managers' and 'advisors' both in governmental and non-governmental organisations. The scope for such roles under the World Conservation Strategy (Smyth) is considerable and also offers considreable potential for new educational approaches globally, in sub continents (Roth) and nationally (Plummer, Ling). These exemplify the basic need and importance of maintaining varied perspectives in environmental training and educational programmes.

In Section B (Implementation and Practice) contributions describe how environmental programmes achieve their interdisciplinary and holistic aims. In the keynote papers, Sacks and Emmelin concentrate on typical scenarios found in North America and Scandanavia respectively. Blair, Thomas, Patrick and Smith outline parallel case studies for the U.K. and Australia in universities and colleges with under and post-graduate levels. A popular framework to achieve coherence and unity in environmental courses is offered in Odum's invited paper on systems, especially energy systems. The following group of papers by Mottershead, Moscardini, Moffat and Prowse provide further illustrations and applications of the systems approach in environmental studies. The section concludes with case studies that relate to teaching applications and a paper on validating Environmental Science/ Studies degrees (Kliger and McPhee) demonstrates the relevance of theoretical and conceptual ideas.

The final section of this volume (Vocational Training and Education for Life) begins with keynote paper by Barrass who suggests that understanding and caring for the environment should be taught across the school curriculum and that well-written books are needed not only by students of environmental studies but also by others who make decisions affecting the environment. Examples of curricular interpretations of how this can be achieved are given by Aho (Finland) and Williams (Global Environmental Education Project). The performance and characteristics of environmentally trained students concern

Goodger and McPhee, Blair and Dugdale, Llewellyn and Steele who consider career and employment prospects of students taking courses in Environmental Studies. A review of the development of Environmental Health as a discipline and of courses for Environmental Health Officers by Cusack and Wood serves to indicate the importance of vocational training; as does Potter's analysis of the need for specially trained technicians to monitor pollution, with reference to Higher National Diploma courses in Environmental Analysis and Monitoring, Conservation Management and Energy Management in the U.K. The need to extend environmental education beyond academic boundaries and to embrace community objectives is illustrated by Lovie (England), Butler (Scotland) and Dierking and Falk (USA). The papers emphasise the role of conservation and citizen participation and remind us of the various educational and philosophical criteria outlined in Section A.

It has not been possible for reasons of space to include any of the valuable discussion, questions and answers which emanated from these papers, or to capture any of the live and stimulating interactions between the presenters of the papers and the delegates. Naturally, many questions remained unanswered and new issues emerged which will require further consideration. However, as a contribution to the 'state of the art' in the mid 1980's it is hoped that this volume is a helpful and informative reference book on the dynamic and intriguing field of Environmental Science/Studies in Higher Education.

R. Barrass
D.J. Blair
P.H. Garnham
A.O. Moscardini

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ENVIRONMENTAL LEARNING : SOME JUDGEMENTS OF TIME AND SCHOLARSHIP

D.R. Denman
Cambridge University, England

INTRODUCTION

Twenty years ago we were in the 1960's. It was the decade of doom. Prophets, more zealous than informed, shot cannonade after connonade of statistics over us, to rain down in judgements and predicted catastrophes. The end was nigh. Greed had multiplied as knowledge advanced to destroy the resources of earth and mankind upon it. Fortunately, men of stronger mind and surer vision, notably Michel Batisse of UNESCO's Man and the Biosphere, brought balance to judgement. Speaking to the World Council of Churches, Battisse said:

> "Some of the impending catastrophes we hear about are only based on figures, repeated from one newspaper to another, which have no great scientific value insofar as accuracy is concerned. No real systematic observing or monitoring of the changes which have taken place in the biosphere, or at least of the most important variables concerned, has in fact been done".

So we took breath. We had Stockholm, the World Conference on the Human Environment, to usher in the 1970's and call us to a more sober and sounder mind. We needed to educate ourselves. The world of science had indeed so advanced the frontiers of knowledge that those who pioneered out there lived in ever deeper groves of abstraction. Intelligent interchange, even between scientists, had become difficult if not impossible. Yet is was the propulsion of discoveries in the biological and physical fundamentals which equipped inventors to devise new technologies for the mastery of nature, the consumption, exhaustion and pollution of earth's resources and which enabled the conquest of disease, the natural sickle which over all past generations had prunned the inordinate proliferation of the human species.

It was as if, tunnelling for new light, we were in danger of bringing the tunnel roof down upon ourselves. Someone has to stand back and look at the process as a whole; to learn how to learn about what was happening. Thus, in the 1970's, space was found for environmental scholarship. What were little more than cautionary courses were introduced amongst the orthodox. Here and there, also, a kind of academic deception was practiced by rolling departments of architecture, geography, town planning and the like into composite faculties of Environment Studies, Environmental and Life Sciences and similar denominations - without altering the substance of the curricula. But the question which begged for an answer was whether knowledge of man and his environment was, or could become, a subject standing in its own right, capable of academic recognition and development. Only those bold spirits who dared to make the assumption and act upon it, could apply the test. Now, some ten years later, in the 1980's, we are better able to read the evidence supplied by these endeavours. What are the judgements of time and scholarship upon them? We ask the question at the opening session because by looking back over the past we can best help ourselves to see the way forward.

REAL OR MAKE-BELIEVE

Whatever progress has been made, we are still in the wood of sceptism. There is a lot of convincing yet to do. The world of learning does not deny that man has a relationship with nature and with the realms of mind and spirit. But, it is asked, have we not, in one way or another, acknowledged this in our formal and currently recognised departments of knowledge - in geography, in applied sciences, in geology and other physical sciences, in medicine, the social sciences, architecture, applied economics, law - political science even, not to mention anthropology and the perspectives of archaeology and history. All these, after their fashion, study man in his environment and human condition. What is this new science of the environment and human condition? What is this new science of the environment you would have us know? Is it material or ghost, real or make-believe; is it, as with the Greeks of old, but another monument to an unknown and unknowable god? The answer lies not in a name - 'environmental science' - but in the empiricism of the courses so far established and their scholastic justification. The measure of this defence we shall look at a little later on when we look briefly at the scholastic criteria by which the new teaching should be judged.

CHANCE, CHANGE AND CONTRADICTION

In the meantime, let us forget the adversary. Let us have a little 'at home' chat among ourselves. For we owe it to ourselves to be candid about man and his environment as a field of study. We should admit that in its myriad deeps and wide ranges there lie the indeterminacy of chance, the perversity of change and the ambiguity of contradiction. There are no neat and tidy formulae, no hypotheses supported on logical foundations, no absolute verities. Let me briefly explain what I mean. Chance: Nietzsche reminded us that man was the animal who made promises, the creature of memory and hope. If he were not so, we would live only with the present moment and there would be no environmental problem. The present moment is its own vindicator. We tolerate the present and it tolerates us. Our concern is with the moment after next and with those that follow, to the horizons of time. We are bent to fashion a tomorrow we cannot see. We must therefore take chances. It was so with our fathers before us. They made promises and took chances. As the past took chances and made promises for our today, so must we do for the coming tomorrow. We cannot make a sure prognosis; only a promise.

Past generations mastered and moulded the environment and were fashioned individually and jointly by it, body and soul. The past, in its way, was as sensitive to and as moody about the totality of the environment as are the latest 'green' agitators. There is a telling passage in Johnson's Lives of the Poets when he writes of Milton and his contemporaries to say: 'There prevailed in Milton's time an opinion that the world was in decay and that we have had the misfortune to be produced in the decrepitude of nature'. Former generations took stock in their own way and we have inherited the promises of yesterday. History is misread and our forebears misjudged if we suppose that someone sat down deliberately to plan and produce ugliness, although their thoughts and their work may so strike us now. No factory owner, landowner, architect or surveyor purposely set out to make the Black Country what it is today. Their motives were to provide shelter for working families within reach of the factory door and the family pocket. The ugly results, by the light of later experience and wisdom appear as errors but they could not have been foreseen and certainly were not deliberately wished on us. Man errs because he learns, said Proudhon. Likewise, it is wrong to accuse the present generation of setting itself the goal of reducing the environment to rubble in the shortest possible time. Let us, then, take a balanced view of things and acknowledge how events can fortuitously and happily move in an opposite direction. Fields and hedgerows, the warp and the woof of the garden which is the English countryside of today, are the consequence not of the work of an eighteenth century prophet with rising hope of a new environment in his eyes, but of practical men, Benthamites, who planned to use land and resources to suit a new agrarian order destined to replace the disutilities of the open fields of Anglo-Saxon England.

Changes: Because the environmental problem is a function of time, it is also a function of change. Circumstances and ideas change with time. What we today see and teach as the fairest promises for tomorrow will doubtless seem to our descendants maleficent. Cannot we hear them talking about our architecture, sitting in solemn and heavy judgement upon it as the grossest expression of human creative genius known to history? Our steel and glass tower blocks will, perhaps, for them, be the horror houses of yesterday. By then, the environmental biologists with their notion of the tropics as man's natural habitat, the surroundings and climate wherein he can be most truly himself, may have taken over and, together with advanced meteorological technology, will have London in a constant swelter of tropical heat and Downing Street lined with paw-paw trees.

The present emphasis on development as an economic phenomenon and the divide it drives between developed and developing countries is unfortunate. It obscures the truth of history. Civilisations, as Toynbee has told us, develop in their own way. Many so-called developing countries in the modern categories had a mature culture and way of life, accepted, lived and enjoyed centuries before the developed countries were nations at all. Differences lie in the interaction between environment and social order, outlook and ethos.

A society near to the ways of nature tends to be more visceral and vital. Merry England belonged to the days of oxen ploughs, open fields and maypoles; and African peoples, it has been said, do not conceptualise their religion - they dance it. The economic development which divides the nations is better seen as environmental change; and as change it should not be shied at. Change itself is among the most essential elements of a healthy human environment. The stagnant, the immutable is the lifeless. Charles Darwin in *The Descent of Man* observes the need for change in human surroundings and points the lesson with a parable when he writes: 'If all our women were to become as beautiful as the Venus of Medici, we should for a time be charmed but we should soon wish for variety; and as soon as we had obtained variety, we should wish to see certain characters a little exaggerated'. Perhaps this is what J.B. Bury had in mind when he maintained that the length of Cleopatra's nose was a determining factor in creating the Roman Empire. The mere fact that the human environment is changing before our eyes is all of a piece with past history and should not in itself cause alarm. We are called upon, nevertheless, to understand the changes. In the context of them, today's promises are addressed to the future.

Contradiction The road ahead is forked with contradiction. There is no single, clear-cut pathway. One lobby of opinion, for example, is alarmed at the death potential of the atom bomb and its threat to the continuation of human life on earth; and another lobby by the unprecedented expansion of human life in the shape of the population explosion. Again, one school of environmental scientists alerts us to the steady decrease over the last two decades in the mean temperature of the earth's surface due to the accumulation of particles and aerosols suspended in the atmosphere and the consequential reduction in the earth's *albedo*. Other expert opinion, on the contrary, is convinced of the addition of carbon dioxide to the atomsphere from the combustion of fossil fuels at a pace which can but increase the retention of heat from long-wave solar radiation. Strong arguments are advanced for reducing attempts to use nuclear power for civilian purposes. Against these arguments stand the optimists with eyes lifted to new horizons of promise, to giant *nuplex* systems using nuclear power to desalinate sea water and energise vast agro-industrial enterprises capable of turning coastal desert into rose-gardens. And, more sober, but nonetheless sure, the Ashby Commission in its first report appears to accept a future for industry equipped with nuclear power, despite the contentions of those who regard atomic energy as too 'hot' an effluent to handle and beyond the ability of human ingenuity to contain within the bounds of safety. Seen in this perspective, the human environment issues appear as today's version of an age-old involvement.

THE NEW AWARENESS

The age-old involvement with the human environment in the past was, at most, incidental to familiar, work-a-day affairs. People were far too busy and single-eyed to pay attention to the environment as a phenomenon in itself. Operators were concerned with the first consequences of their actions, whether building cities, enclosing the land, opening the mines or administering medicine. The environment was a secondary consequence and looked after itself. It was never or seldom above the threshold of conscious action. Today's alertness and awareness mark the difference. For us life and life, life and inert nature are coupled in relationships, both beyond and within the human regime; relationships which Arthur Tansley has taught us to designate as ecosystems.

In these, the first lineaments of environmental studies (or environmental science) are discernible. We should keep them in our sights. We are in danger of running beyond them, of going too far and too fast. From particular environmental chains of inter-related actions and reactions - cultivation, food production, nutrition and health, for example - theory is pressing forward towards the conception of the human environment as a whole, as a comprehensive entity in itself, a seamless integument of mankind. Time and again, in the literature of environmental studies and *human ecology* and especially in the declared aspirations of educators, we come across the word '*holistic*'.

I draw your attention to this practice as the logical implication of the proper use of this word undermines the case we are striving to make for the recognition of the study of the human environment as an acceptable academic discipline. The logical use of the word carries its own contradiction and exposes our flank to the critics. To study the wholeness of the environment of man in relation to the whole man does not permit the exclusion of any iota. Man's total learning, factual and potential, is part of that whole. Furthermore, it denotes the whole of his philosophical, political and religious experience and understanding of himself, his neighbour and his god. Anything less denies the logic and proper meaning of 'holistic'. Manifestly, therefore, it has no practical validity. Those who essay to frame curricula upon it deny, in the very process, their avowed ideals. No one person can comprehend the totality of man's learning. Those who try to articulate courses to an 'holistic' end ape the fluttering butterfly alighting here and alighting there to sample the esters in the academic garden; here a little, there a little, the very antithesis of the imperial demands of the holistic conception.

Moreover, the holistic aspiration can lead to serious incongruities. What is the end purpose of environmental studies but to equip us to know how to live in harmony with our environment? If, in our comprehension, we are to cover, truly, the whole of man's environmental experience, we cannot avoid religion and politics. Admittedly, we can neuter the emotions, by studying the former as man's relation with the numinous and the latter as political philosophy. But if study is to lead to action, we must deal with action in the real world. There religion cannot avoid beliefs and doctrines, nor politics commitment to partisan policies. Both, especially religion, are the seats of the most virulent conflicts between man and man. To point to the religion behind all religions, as some do, is no get-out; in doing so we are simply introducing another doctrine among contesting doctrines. In short, to be true to the logic of the holistic approach to environment studies and human ecology leads into discord, not harmony.

SCHOLASTIC CRITERIA

In entering a caveat against the holistic conception, I must commend its use insofar as it is an attempt to define and designate the heart of environmental science, without which the subject cannot take or find its place among other subjects in the higher education portfolio. Its use reminds us that we have not yet 'found' the subject we are wishing to study. This task of simple identity should be first among the priorities which concern this conference. My few brief remarks are directed to that end. Before I try to be more specific, it will be necessary to make a short excursion into the lecture room and studies of the universities and other seats of higher learning to seek the criteria of scholarship. The search, I believe, will help us to find our subject.

Of all the terms from the world of learning which, by dropping into common speech, have become misshapen in meaning, none has suffered more than the world 'discipline'. Formerly we spoke of subjects where today we refer glibly to 'discipline' - that is, when we are not committing even more vicious violence to the language by referring to 'areas'.

'Areas' are nonsense. 'Discipline' has an aristrocratic origin which should command respect. It is an informative word, denoting study of a subject at University level (or the equivalent) so organised as to discipline the mind - to school the scholar to think concisely, analytically and comprehensively, to the end that he can intelligently communicate and comprehend. To bestow the ability to think, must surely be the first ambition of the University teacher. Absorbtion of facts at random, uncoordinated and uninterpreted, can confuse rather than edify. Facts are important. Even so, the discipline of an interpretative theory can convert a memory test into a scholastic discipline. The relationship between 'facts' and 'theory' was well put by Arnold Nash in his The University and the Modern World when he said, 'From Morris Ginsberg I learnt that not even the clearest thinking can atone for failure to begin with facts, while from Professor Karl Mannheim I learnt that the facts are never what they seem to be'. They need the discipline of theory.

The problem before the environmental scientist is to know how, if he is to command respect in academic circles, to devise a discipline from courses of study derived from abstractions from a wide array of subjects and organised as an academic discipline in its own right. To take a slice of economics and call it 'environmental economics'; or law and call it 'environmental law' is only playing with names. It can rightly infuriate the academic economist and lawyer. It appears to them to disparage their true 'disciplines'. Incidentally, 'Economics in relation to the human environment' and 'Law as applied to the human environment' denote a dependence upon these disciplines which may achieve the same end without the offence. It is widely held in many universities that study of the human environment is so complex and derivative that it is unsuited to undergraduate learning. Only minds first disciplined by orthodox undergraduate teaching should attempt the synthesis of knitting together the strands of knowledge which make up environmental studies.

Moreover, principles and theory in environmental studies has another important function in the provision of sound education, especially for the practitioner. In a world, such as ours, of dynamic technological change, the facts of today soon become the out-of-date know-how of yesterday. The academic and the pracitioner need to be schooled so as to comprehend new knowledge and ideas, as and when obsolescent practices make room for them. Learning current facts, although they were the sum of knowledge at the time of learning, does little to contribute to a true education.

CURRENT EXPERIMENTS

How then can, or does, environmental science or human ecology face up to the academic imperative and present itself as an academic discipline in its own right? It is a daunting question to answer. Various international, woolly-minded conferences on the subject have done little to help. Take, for example, Recommendation 13 of the Tbilisi International Environmental Education Conference held in 1977. Besides telling universities and colleges that education will become increasingly different from traditional education (without saying how) it went on to require them.

To develop close co-operation between different university institutions (departments, faculties, etc.) with the specific objective of training experts in environmental education; such co-operation might assume different forms in line with the structure of university education in each country, but should combine contributions from Physics, Chemistry, Biology, Ecology, Geography, Socio-Economic Studies, Ethics, Education Sciences and Aesthetic Education etc..

Here is the butterfly at work again (it reminds me of the old song - I'm looking for the Ogo-Pogo). It is difficult to see what exactly the conference was getting at. At one place the Pesolution says 'education will become different from traditional education' and in another upholds the 'structure of education in each country'. The implication is that in order to teach environmental education (that is one subject) the entire education tradition will have to alter. I cannot think that sentiments on these lines can advance the cause of environmental education in traditional universities or in right-thinking institutions anywhere.

Butterfly programmes on these lines are not to their liking. For them academic discipline, as a primary criterion, and the ever widening boundaries of factual knowledge of the human environment and its problems exert a pull-devil-pull-baker tug to claim the attention to those who would frame higher education courses in environmental learning. Experiments in courses and the academic philosophy behind them which have been conducted over the last ten years or so in reputable seats of higher learning, have tended to take three distinguishable forms, according to the manner in which they have sought to solve the facts vs theory problem. For simplicity, I have called these forms - the tree form; the river form and the woodland form.

The Tree Form: This tends to be a first degree option extending over three or four years. The opening year is devoted to studying a few selected orthodox disciplines at elementary level, in the natural sciences and the humanities. The basics contribute to the study of selected features of the human environmental scene in the second year and so prepare the way for options in applied theory in the third or final years. Time is the limiting factor. Either the fundamentals are skimped or the final case studies and related applied knowledge are cramped for want of time.

The River Form: This is patterned round a different principle of abstraction. A particular feature - population, economic development, pollution, environment control, and so on - provides a core subject running, like a river, through the three or four years of the course. Tributary, auxiliary subjects are fed into the main stream to swell it and link it with other aspects of the human environment. This pattern is far removed from the 'holistic' ideal; but as a pattern from a first degree course in environmental studies, it has much to commend it, especially as a means of providing an intellectual discipline.

The Woodland Form: This stands apart from the other two. It demands maturity and, hence, a trained, disciplined intellect as a passport to entry. Only graduates or mature professionals with academic credentials, the equivalent to a first honours degree, are admissible. All scholars are postgraduate. As individual trees in a woodland stand apart yet meet in a common canopy, so graduates from a wide range of academic studies and professions, as specialist academics or practitioners, are individually introduced to environmental studies in a manner best suited to fit the peculiar academic training or professional calling of each. To my mind, this form best relates academic disciplines and factual information studies. The range of mature environmental studies (the canopy of the woodland) offered to the graduates varies with the facilities, departments and teaching arrangements of the University - Monash in Australia boasts of no less than 150.

PROSPECTS FOR A DISCIPLINE

When, some years ago, the UK Government established a Department of the Environment, it humped together, under that name, existing Departments and Ministries - transport, housing, town planning, local government and others. Environment was a convenient 'dustbin'. The functions of the component departments, however, did not change. We have already noticed how, in certain universities, something similar has happened and new names - Environmental Studies and their ilk - have appeared almost over night in the University Calendars.

Arrangements of this kind may slake the thirst of international lobbies panting for the academic recognition of the human environment in modern learning. But it got nowhere towards establishing a recognisable and acceptable discipline peculiar to the environment. The courses in environmental science and human ecology whose patterns we have just categorised make positive advances in the right direction. Even so, I would wish to conclude my remarks to you by suggesting that we in the academic world, anxious to promote studies related to the human environment, need to sculpture a more perfect form. One thing is certain: the human environment has no uniformity of feature. Whosoever studies to understand it must accept the relativities of wide variations, in locations, cultures, development and other varieties and make allowance for chance, change and contradiction What should be sought after is a formula which has universal application and relevance to whatever particular variation is studied and which, in the bargain, would combine the academic subjects of which studies of the environment must be composed into a set of interpretive principles.

To illustrate more precisely what I mean , allow me to indulge, for a moment, in an autobiographical reminiscence. For many years, I was struggling with land management studies at Cambridge University, trying to find a formula to justify them as an academic discipline. The courses were derivative, dependent upon economics, law and the primary technologies of agriculture, forestry and construction. We discovered in what we called the 'Proprietary Land Unit'(PLU) the formula which bound the components into a universally relevant unit of analysis and synthesis. The PLU was the basic decision-making unit, defined by law (no matter what the specific juridical system might be) within which decisions for the management of resources were taken under the influence of economic and social criteria and the limits of technological constraints. It has been accepted as the basis of land economy as a discipline not only at Cambridge but in many other universities throughout the world.

Might I suggest that the equilibrium of a perfectly functioning eco-system could be the clue to just such a common base for environmental science. The different forms of eco-system, including the human, offer a calculus of equilibria which could hold all the promises of a sound discipline, capable of sustaining academic study at undergraduate and graduate levels. There is no

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time and this is not the place to pursue this thought in any detail. I have, however, developed it a little further in an Appendix to the Paper. This gives an outline schedule of universally relevant fundamentals under the rubric - Principles of Interpretative Analysis Applied to Eco-Systems Within the Human Environment.

Admittedly, a great deal of thought and research are needed to develop this notion. But I believe it could lead to the fashioning of a tool useful to sculpture an academic discipline for environmental science and human ecology, and if nexessary, a handy and effective weapon to crack your critic's head with.

APPENDIX

THE ECO-SYSTEM AS THE FUNDAMENTAL CO-ORDINATING UNIT IN ENVIRONMENTAL ANALYSIS AND SYNTHESIS

A disciplined interpretative analysis and synthesis could be provided as a common core to all aspects of higher environmental learning by using the concept of the eco-system as the fundamental unit of interpretation; and introducing the method by a mandatory course on the following (or similar) lines:

Criteria of Relative Judgement: Introduction to the concept of the perfectly functioning eco-system and the basic principles of harmony, wholeness and health as ideals in human living conditions and the relative nature of the judgements and criteria which must be made and used in the application of those principles.

The Eco-System in the Natural Order: The function of eco-systems in the physical environment - its natural resources, continuous, reproductive and exhaustive and its benign and hostile attributes.

The Eco-System in the Human Order: The function of eco-systems in man's relationship with the natural order and with himself in the realms of the political, economic and social pressure.

The Eco-System and the Metaphysical: The effect upon eco-systems of mans's response to the natural order and to himself as determined by religious and other metaphysical interpretations of life and human relationships.

Policies and Practice: The effect upon eco-systems of the way decisions are taken in practice through the use of instruments of Government and as private initiatives, individual and corporate.

Historical Perspectives: The way in which past policies and practice have affected the functioning of eco-systems, for good or bad, in the present human environment.

ENVIRONMENTAL PHILOSOPHY AND ENVIRONMENTAL SCIENCE

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INTRODUCTION*

According to O'Riordan (1981), environmentalism is characterised by two distinct *modes* or approaches to the environment and to environmental 'problems'. One, which he calls *Technocentrism*, subscribes to the application of rational and value-free, 'objective' scientific techniques by a professional elite of managerial specialists, and regards the environmental as 'neutral stuff', or as a set of 'resources', from which 'Man' (*sic*) can profitably shape 'his' (*sic*) destiny. Technocentrism therefore believes in the ideas of progress, efficiency, rationality and control, but is more concerned with means than with ends.

Conversely, *Ecocentrism* presupposes the existence of a 'Natural Order', in which all things operate according to 'Natural Law'. The ecocentric mode therefore preaches the virtues of reverence, humility, responsibility and care - a natural morality, and demands a code of behaviour based upon the 'ecological' principles of diversity and homeostasis, that seek permanence and stability, and which recognise the environmental 'limits' of human activity. Econcentrism is therefore concerned with ends as well as means, and advocates a radical change in society, in favour of decentralised, self-reliant, small-scale communities, practising participatory democracy and employing alternative technology. Some ecocentrists are 'anti-science' in their views, whereas others advocate a new kind of science, and a new technology, which will be used to liberate people rather than oppress them.

ENVIRONMENTAL SCIENCE AND ENVIRONMENTAL PHILOSOPHY

Many ecocenvists do not consider technocentrists to be environmentalists at all. Environmental Science, with its aspirations towards management must then of necessity, arouse deep suspicion within the ecocenvist. At the heart of this dichotomy is the concept of *dualism*, that is, the separation of people (*Man*) (*sic*) from the rest of the environment (*Nature*).

Technocentrism, with its emphasis upon intervention, management and manipulation of the environment by 'Man', is clearly dualistic, whereas ecocentrism, which subscribes to natural laws and limits, is *monistic*. For some radical environmentalists, this is a damning criticism of technocentrism (Capra, 1983) and one which some feel is leading Environmental Science up a philosophical blind alley. For just as one cannot create holism out of reductionism, neither can dualism, which presupposes separateness and dominance, lead to reconciliation.

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Dualism, in the Western tradition, has a long history (Glacken, 1967; Hart, 1980; Passmore, 1980). It may be found, for example, amongst the Ancient Greeks, in the teachings of Aristotle and in the two main schools of philosophy of this period (the *Epicureans* and the *Stoics*). These ideas later found their way into Western (as opposed to Eastern, Orthodox) Christianity via the writings of St. Paul (*ca* A.D. 10-*ca* 67), St. Augustine of Hippo (354-430 A.D.) and St. Thomas Aquinas (1225-1274), Francis Bacon (1561-1626), and Rene Descartes (1596-1650), the last of whom is considered by many to have been the founder of modern Western philosophy.

In recent years, both Bacon and Descartes have received a critical mauling at the pens of environmentalist and futurist writers, expecially Capra (1983), Hart (1980) and Henderson (1983). Critics of modern, Western, science-based technologists society point to what has been termed the *Baconian-Cartesian* position or attitude (Passmore, 1978) as being one of the root causes of present environmental mismanagement and disruption. It is dangerous to quote out of context, of course, but several authors (e.g. Capra, 1983; Hart, 1980; Merchant, 1979) have cited Bacon's advocacy of the use of scientific knowledge to gain mastery over 'Nature', and Descartes' aspiration to the development of 'a practical philosophy ... whereby we can render ourselves the masters and possessors of Nature' (quoted in Passmore, 1980, p 20) as evidence of the readical transformation of Western thought, during the Renaissance, Reformation and Early Modern times, and the development of a dualistic science designed to increase the dominance of 'Man' over 'Nature'.

From Descartes we also inherit the idea of the Universe as an intricate clock-like mechanism, which is best understood by examining, in greater and greater detail, its constituent parts. Descartes also appears to have been responsible for the bringing together of science and technology, which until then had been separate activities. Whilst dualism was already present in Western culture well before the seventeenth century, it was the combination of that idea with reductionism and the mechanistic view of the world propounded by Descartes that allowed the development of Western science along the narrow lines of disciplinarity and ever-increasing (until recently) specialisation. Environmental Science, which seeks to reverse this trend, therefore runs counter to the thrust of Baconian-Cartesian thought.

In philosophical terms, Technocentrisms,with its emphasis on manipulation, management and control, is clearly part of the Baconian-Cartesian tradition, and is therefore the Environmentalism of the present dualistic paradigm. Ecocentrism, with its emphasis on reverence and forbearance, clearly originates from a different set of philosophical principles, and is the Environmentalism partly of the Pre-Renaissance past, and partly of some ideal future.

Consequentily we therefore come to a contradiction in Environmental Science as presently constituted, which is that on the one hand it possesses aspirations towards holism, but that on the other, it retains a dualistic, reductionist, mechanistic approach to the environment. Technocentric Environmental Science may be interdisciplinary in a narrow dualistic sense, but in broader, monistic terms, it may not be so at all.

ENVIRONMENTAL SCIENCE AND THE NEW PARADIGM

Faced with the conflict between the dualism of Western culture, and the essential 'inter-connectedness' (Holism) of the environment, several writers (Capra, 1983; Henderson, 1983; Roberstond, 1983) have called for a shift in Western thought, and the development of a new, environmentally-conscious social paradigm. This Capra, and Henderson call 'The Solar Age', Robertson the 'SHE (Sane, Humane, Ecological) Future'. According to these authors, this paradigm shift would involve radical changes in our dominant ideas about the nature of growth, work, wealth and power, and would bring about a non-hierarchical, decentralised, small-scale, self-reliant society very similar to that of liberal utopian environmentalist (see Cotgrove, 1976).

It would also require the development of a new kind of science, one whose basic constructs reflected the shift in thinking which had taken place, and which was holistic rather than reductionist in its approach. This science would consider pattern rather than mechanism (Bateson, 1979), and would not separate us from the rest of Nature. Environmental Science, or Ecology in the broad sense, is probably the closest thing to the science of this new paradigm we possess, but in order to fully realise that particular aim, it needs to transcend the dualistic, mechanistic influence of technocentrism. Here, we come across several stumbling blocks, within ecocentrism there are 'anti-science' elements based on 'feeling versus thought' (Cotgrove, 1976). This is particularly true of conservative, traditional utopian thinking, in which science and the scientific method are replaced by ritual, and by strong laws embedded in natural morality (see e.g. Goldsmith, 1978).

However, other aspects of ecocentrism, especially the issues centred around decentralisation, liberation, and alternative or 'soft' technology, also involve the development of a new, more radical science (Sandbach, 1980). Environmental Science, if it can rid itself of the Cartesian inheritance of Technocentrism, has the opportunity to become this new science. The way forward appears to be among the 'softening' pathway, via the quest for behavioural solutions to problems created by 'hard', mechanistic thinking and actions (Morrison, 1980). Instead of a reductionist approach, what seems desirable is an holistic one which involves integration of the physical, biological and cultural parts of the environment, and a new synthesis of ideas from a very wide range of sources. I do not pretend that I have anything like a complete notion of what these will be, and in any case Henderson (1983) and Robertson (1983) point out that in *this* context, plurality may be a virtue. However, it seems likely that a society based on a new, ecological paradigm would possess very different ideas in four key areas - growth, wealth, work, and power (Robertson, 1983).

GROWTH

A basic characteristics of the present social paradigm (beside dualism), is the concept of growth, and that expansion is somehow part of the 'natural order of things'. In the past, several economists (e.g. Boulding, 1966; Daly, 1973) have proposed an alternative set of principles, centred on the steady-state or no-growth economy, and yet, fifteen to twenty years on, growth as an idea is even more firmly entrenched in our ideas than before.

For the origins of the growth paradigm we need to look beyond the Baconian-Cartesian model, and to other philosophical ideas developed a little later, especially by John Locke (1632-1704). These in turn influenced the Classical Economists especially Adam Smith (1723-90), and David Ricardo (1772-1823), and led to the development of the principle, firmly enshrined in modern economics, that economic growth is not only a necessity for 'progress', but even that growth is some kind of fundamental human characteristic.

We do not need to rehearse here the many criticisms of the growth paradigm made by environmentalists over the last fifteen to twenty years. What perhaps we *do* need to note is that the development of reductionist Cartesian science was parelleled, in the humanities, by the emergence of *expansionist* ideas, which in part gave rise to the extraordinary period of economic growth and colonisation of the rest of the world experienced by the Western nations from the mid-Eighteenth century onwards. Many environmentalists feel that it is the overwhelming success of this expansionist culture, and at the same time its manifest contradictions and weaknesses (especially dualism), which have led us to the present hazardous state of affairs.

If we are to substitute for the paradigm of growth, some kind of self-reliant, steady-state society, then an important task at the 'soft' end of Environmental Science is to search for ways into this future (Dunlap and Catton, 1978). However, what also must be avoided are the repressive aspects of some of the stationary-state societies which have been described (Boulding, 1973; Goldsmith, 1978; Heilbroner, 1974). This could perhaps be achieved on the one hand by a continued dialogue between environmental scientists, and anthropologists, who have practical knowledge of stable societies (Preston-Whyte, 1979), and on the other by reference to nineteenth century models and experiments in small-scale society building (e.g. Ward, 1974).

WEALTH

One of the fundamental principles of Environmental Science (O'Sullivan 1980), and especially of Technocentrism, is that the environment may be regarded as consisting of wealth, i.e. a stock of resources. Whether we regard these as a set of objects to be ruthlessly exploited, or as wealth to be wisely managed, both attituded separate us from the rest of 'Nature'.

Here I think Lynn White's much criticised (1967) article has a very important point to make, which is that Judaeo-Christian-Islamic religions differ from most of those that they eventually replaced, in their rejection of the idea tht all natural objects and places (rivers, trees, hills, rocks, lakes, woods, animals) are permeated by some kind of 'life-force', 'spirit' or 'genius-loci'. As originally conceived, this conferred upon the rest of the natural world the same inalienable identities and rights as were the perogative of humans.

This concept, called by anthropologists animism, is a characteristic of very many 'primitive' religions, but is clearly one which we, in the West, in modern times, have almost totally lost. However, animism was a characteristic of the old European religions which Chrisianity replaced, as can be seen in the literature of many European countries. Many north American Environmentalists (e.g. Snyder, 1984) have also referred to its existence in the cosmologies of the indigenous peoples of that continent. 'Deep' environmentalists attribute our exploitative attitude to the environment, and our failure to recognise 'biorights', to the absence of this concept from modern Western culture. Similarly, other ecocentrists point to parallelisms between animistic views of the 'inter-connectedness' of all things, and ecology (sensu lato).

For many, all this remained nothing more than coincidence until quite recently, when Lovelock (1979) proposed that the Earth itself is in fact a single, self-regulating system, which he calls (after the Ancient Green mother goddess) Gaia. In essence, what he is saying is that the Earth may be regarded as a self-regulating system in which organisms, especially microorganisms, play a crucial role in maintaining the chemical composition of the atmosphere (and to a lesser extent the oceans). In this way, life itself has maintained the hospitable nature of the Earth for some 3 x 10^9 years.

For environmentalists, the Gaia hypothesis offers a number of possibilities (O'Riordan, 1984). First, there is the idea, advanced by Lovelock himself, that if Gaia does operate in the way he thinks she does, then we humans are not a particularly significant part of the system, and certainly far less important than anaerobic bacteria or ruminant herbivores. Therefore, if Lovelock is correct, we should begin to think of ourselves less as the rulers of Nature, and more as a minority in a very democratic planetary society.

Clearly, this has fundamental implications for a dualistic culture such as our own. If Lovelock is correct, there is not only a moral basis for 'biorights' and the survival of other species and ecosystems, but there are strong biogeochemical grounds for regarding some as more important than ourselves, and certainly for giving the maintenance of Gaia herself a greater priority than our own survival (Clark, 1983). However, having made his discovery, Lovelock then comes to what I find to be a very curious conclusion. For what he appears to advocate is that as the 'eyes and ears' of Gaia, we should attempt to manipulate and manage her for our own ends. This is a very dualistic and mechanistic reaction to what is potentially a staggeringly powerful holistic concept.

O'Riordan (1984) also highlights the mystical aspects of Gaia. Here we may say that what Gaia offers ecocentristis (for whom incidentally, Lovelock is full of ill-informed contempt) is a powerful reaffirmation, couched in modern, scientific terms, of the same 'interconnectedness' present in the old, animistic religions. Also, recalling what Glacken (1967) has written, we may say that the Gaia hypothesis provides fresh impetus for the ancient idea of the designed earth, although clearly, as the Gaia system is self-regulatory and self-organising, all teleological connotations of that concept must now be removed. For ecocentrics then, perhaps Lovelock's most valuable contribution (and one which he would almost certainly not applaud!) is to provide them with a strong argument for making an end of our dualistic view of 'Man' as separate from 'Nature'.

Curiously, the parallelisms between 'primitive' animism and modern ecological thought do not end even there. The anthrophologist Gregory Bateson (1972) proposed that all organisms, societies and ecosystems prossessed a characteristic that he called Mind. This he defined as the capacity to process information and to develop the phenomena we associate with Mind - thinking, learning and memory (Capra, 1983). According to Bateson, Mind is present not only in humans, but in all other organisms (long before they develop a brain and a higher nervous system), and in all self-organising, self-regulating systems (ecosystems, watersheds, societies) whether we would normally consider them animate or not. Mind then is present not only in the bodies of humans and other 'higher' organisms, but outside them as well. Consquently there may not only be moral and biogeochemical reasons for considering ourselves part of a very demoncratic planetary community, but also cybernetic and psychological ones as well.

An ecocentrist redefinition of wealth would therefore substitute for the dualistic concept of 'Resources' the view that the environment consists of a set of closely inter-related, self-organising, self-regulating, mutually independent entities of which humans, their settlements, economics, societies and cultures, are only a part. On this basis, wealth consists not of a set of resources to be extracted on a 'flow' basis, but a 'stock' of positional goods and relationships

(Hirsch, 1977) which are the true wealth of any community, and which must be carefully maintained on both a local and a planetary level.

WORK

In his description of how we may reach the Sane, Human, Ecological Future, James Robertson (1983) states that one important change that we need to make is in our idea of what constitutes Work. According to Robertson, in the SHE society, there would be less distinction between work and leisure. Work would be deinstitutionalsed, and integrated into other aspects of our lives. Services would become more important than manufacturing (this is of course happening anyway), and Work would involve a much wider range of activites, many of which at present we do not regard as work at all (or which we call 'women's work').

Robertson maintains that, at present, improved productivity leads to less work, whilst at the same time, some important work does not get done at all, or is done 'voluntarily'. Work for unskilled and semi-skilled people becomes scarcer and scarcer, whereas 'expert' work more and more. All these contradictions stem from the distorted definitions of wealth referred to above. A new Work paradigm would involve a redefinition of work, to include informal activities, the satisfactionof human needs rather than the production of 'goods', and the full use of human potential on an integrated mental and physical basis (i.e. an end to the distinction between 'brain work' and 'body work').

These ideas which are of crucial relevance today, have a long and distinguished pedigree, via Schumacher and Gandhi, back into the nineteenth century and to Peter Kropotkin (1842-1921), and William Morris (1834-96). For example, in Fields, Factories, Workshops (1919), Kropotkin (see Ward, 1974) attacked the idea of centralisation in agriculture, industry and society, on the grounds that it led to the specialisation of labour, which is alienating and dehumanising. Kropotkin proposed that instead, society should be organised around self-reliant, self-governing industrial villages, in which craft and cottage industries were practised alongside intensive, garden agriculture. In these communities, labour would be integrated rather than specialised, and each person would be a performer of both manual and mental work, and a producer of both material and non-material goods.

Perhaps the nineteenth century writer who worked out his ideas on this subject to the greatest extend, however, was William Morris (Lindsay, 1979). A constant preoccupation of Morris's life was the nature and role in society, of Work. He pursued this idea in a series of essays, the first of which was The Lesser Arts (1877).

In this he described the effect upon Work of the specialisation of labour introduced by the Industrial Revolution, and compared nineteenth century production methods and quality with those of the

Middle Ages, where (so Morris believed) the distinction between artist and craftsman did not exist. In *Useful Work versus Useless Toil* (1885), Morris of defined Useful Work as involving both physical *and* mental labour and the production of useful and valuable commodities. Anything which did not fulfil these criteria he labelled Useless Toil, which produces only surplus value, and should be abolished.

Morris described the kind of society he thought a change in the nature of work might bring about in his famous depiction of the greening of England, *News from Nowhere* (1891). Here he describes his experiences in an imaginary Southern England of the twenty-first century. Much of the countryside has become wooded, with a deurbanised population practising garden agriculture and workshop industries. The rivers are clear, which points not only to a lack of pollution, but also to the presence (upstream) of forests.

Goods are now made only for use, and work has become pleasure. There has been a great revival in craft skills and the decorative arts. Machines are used only to perform boring, repetitive tasks, and the rest is hand labour. Some processes are still carried out in small factories ('banded workshops'), and there is the widespread use of electric power and water transport. There is free, unstratified exchange of goods in a decentralised society. Women are emancipated, and no longer treated as property. All these changes as Morris consistently shows his narrative, have been made possible by the shift in the way in which society defines Work.

Those contemporary environmentalists who are arguing most forcefully for a change in our idea of the role and nature of Work in society are the ecofeminists, of whom the Women for Life on Earth group are a prominent example. In a recent collection of essays (Caldercott and Leland, 1983), members of the group set out many of the principles of an ecofeminist analysis of environmentalism. For example, King calls for a redefinition of Work to include free self-expression, the avoidance of activites which are destructive of the Earth, and an end to dualistic ideas, which divide and discriminate. Similarly, Thomas explains that technologies which continue to oppress people, and to maintain, or even reinforce, the sexual division of labour in society, are not really alternative in any true sense of the word.

Ecofeminists, as both women and environmentalists, are well-equipped to understand the oppressive role of Work in our present society. Although many have arrived at their critique of the current social paradigm from a more orthodox feminist position, their potential contribution to the 'softening' process in environmentalism is very great. We shall consider this proposition further in the following section.

Econcentrism, via Schumacher, can therefore be shown to be in the inheritor of a radical tradition reaching back into the nineteenth century. Central to this is the thesis that change in the nature and role of Work in society would promote far-reaching changes, including ecological ones. This idea transcends the more limited concept of alternative technology to take in the whole means of production, but is also applied in a more environmentally-aware manner than it is in the writings of Marx. A more holistic Environmental Science would need to take in this idea, and incorporate other aspects of radical and ecofeminist analysis. These are now considered below.

POWER

In his final set of requirements for a shift in our present paradigm, James Robertson (1983) calls for a change in our idea of the nature of Power. He suggests that in the SHE future, people will need power to control their own lives, and to contribute creatively to the lives of others. In order to achieve this, we will need a much more decentralised society, in which dependence upon a centralised authority is reduced, and local communities become much more self-reliant. In this way people will take over responsibility for all of their lives, including the environment.

In calling for these changes, Robertson again echoes Schumacher, and the nineteenth century revolutionaries from whom,via Gandhi, he received these ideas. In particular, decentralisation of society, and an end to the specialisation of labour, go together and are difficult to separate. In other words, shifts in the Work and the Power paradigms go hand-in-hand, the second (as Morris suggested) stemming from the first.

However, as ecofeminist writers are at present showing, even if such a paradigm shift occurred, it would be of little value if a very important principle was not recognised. This is that 'abuse of women cannot be separated from abuse of the land' (Freer, 1983, p 132), or in other words, that the same forces that oppress the environment also oppress people, especially women, (who are therefore of course doubly oppressed).

Yet another seventeenth century philosopher whose ideas have had a marked effect upon our present society is Thomas Hobbes (1588-1679). Of particular relevance here is his treatise on the state, which he called Leviathan (1651). In this, Hobbes put forward the idea that in order to protect people from others, and from themselves, there needs to be a strong, centralised government, whcih will administer justice and protect life and property.

These ideas have found their way into environmentalism, especially the authoritarian solutions to resource allocation recommended by Hardin (1968) and his followers. For radical enviornmentalists, however, and for ecofeminists,the centralisation process, coupled with expansionism, and the exploitation of 'Nature', has led not to freedom, but to oppression. Those nineteenth century writers who recommended an end to the centralised authority of the state all recognised that ecological changes would surely follow. But what ecofeminists are keen to point out is that there is little point in shifting to a new paradigm of environmental awareness, if what also happens is that one form of human oppression is exchanged for another.

The link between the oppression of women, and the exploitation of the environment is extensively documented in the writings of Susan Griffin (1978) and Carolyn Merchant (1980). Both, in rather different ways, have shown how during the philosophical changes which accompanied the Reformation and the Scientific Revolution, the oppression of women increased, mainly because they were closely identified with 'Nature'. For if, as Kant suggested, Nature was a set of objects with no purpose or design, and Man was the master of Nature, and had both means and licence to exploit her, then Woman, (because of menstruation and childbirth) was seen as closer to Nature, and was clearly open to exploitation also. For the same reasons, women were also excluded from 'rational, scientific' pursuit on the grounds that such weighty matters were beyond them.

Many contemporary and nineteenth century environmentalists have made the connection between the separation of Man and Nature, the characterisation of the latter as a set of objects, and its free exploitation, but few (except Morris) have, until recently, linked this with the exploitation of women. However, there is now a growing dialogue between ecofeminism and environmentalism (Henderson, 1983), so that it is probably well past the time when environmental scientists took note of the ecofeminist critique of society.

The name ecofeminists give to the present society is patriarchy (Henderson, 1983). Its characteristics are competition, division, domination, dualism and hierarchy. In its place, ecofeminsits propose a paradigm of co-operation, inter-connection, equality, flexibility, nomism and hetrarchy, and an end to the distinction between people and Nature. In this new paradigm, a completely different attitude to the rest of the environment from the present one of domination and exploitation would emerge. In particular, hierarchy, the dominance of some people over others, and over the rest of 'Nature' would be extinguished.

In summary then, a society which has shaken off the chains of dualism will possess the following attributes. It will emphasise stability, pattern, and cyclical relationships rather than growth, and will consider its wealth to consist of a 'stock' of stable ecological relationships rather than a 'flow' of resources. It will regard work as something which involves pleasure and human fulfilment, and which should not damage the Earth. It will be a small-scale, decentralised, non-hierarchical society in which it will be recognised that the quest for ecological stability and for personal liberation from oppression are one and the same.

Such a society would call for the development not only of a new Art, as Morris knew, but as also, as he implied, of a new Science (Lindsay 1979). Hazel Henderson (1983) suggestes that its characteristics will be that it will transcend 'objectivity' and dualism, and will be based on self-referential, autopoetic logic, where the observer must account for their logical position. This, she proposes, will lead to a more honest science, where the role and impact of the observer, as affecting the experiment or the observations, is clearly acknowledged, and where their motive for studying the phenomena they are interested in will be revealed. The new science will also be reverential, gently descriptive and explanatory, but non-interventionist.

I am not sure I have yet had time to evaluate these ideas for myself, and so I present these here for the reader's consideration. What I would like to add is that clearly an ecocentric science could not possibly be, as Morris put it, 'in the pay of the counting house and the drill-sergeant' (from The Lesser Arts, 1877, see Briggs, 1984), but would be in the service of liberation, not oppression. It would be holistic in its approach, rather than reductionist, and would emphasise pattern rather than mechanism. Beyond this at present I have not been able to go. Environmental Science has the opportunity to become this science, (which for convenience sake I shall now call Eco- (as opposed to Techno-) environmental science), or it can remain within the camp of Technocentrism, and wedded to the present social paradigm.

ECOENVIRONMENTAL SCIENCE AND THE EDUCATIONAL CONTEXT

Just how this new science would be received by the majority of administrators, employers, politicians and academics is fairly easy to forecast. It would possess all the characteristics of the proverbial 'lead balloon'. It would be even more difficult to 'sell' to college authorities, commitees of Senate and the CNAA, and its life in the present U.K. academic climate might well be rather Hobbesian - 'nasty, brutish and short'. In summary, it would possess all the familiar problems that something innovative and different has, but more so.

To begin with, it appears to be completely non-vocational, in the present sense of the word, in that it considers (to paraphrase Morris) not so much how we live, as how we might live. Second, it calls into question the efficacy of, the need for, and the moral basis of, the centralised state, so that it is not going to please many politicians or administrators.

Third, in calling, much more firmly, for an end to discipline boundaries, it comes into an even more direct conflict with institutuional structure than Technoenvironmental Science. Perhaps Ecoenvironmental Science could hope to flourish in the context of a School of Environmental Sciences (as recommended by Emmelin, 1975), but it might even call for something wider and all-embracing (Weidner 1973).

Fourth, it has the potential for creating even more conflict between 'interdisciplinary hawks' and those of their colleagues who do not share their enthusiasm for interdisciplinarity. Indeed, it is my experience that the majority of teachers, trained as they are in a reductionist framework, are suspicious enough of Technoenvironmental Science, let alone a more radical version. This feeling is not confined to those who have never taught or designed courses in Environmental Science (see e.g. Clayton, 1973).

Finally, and perhaps most important, there is the question of how such a science would be received by students. Sadly, in the present atmosphere of mass unemployment, I cannot see Eco-environmental Science being well received by the majority on whom pressure to conform has never been stronger than it is today. Of all the crimes committed against higher education by monetarist economics, this is by far the most serious and most potentially devastating. After all, what a dynamic society needs is flexibility and individuality, not a passive conformism.

In what I can foresee of the future, then, Ecoenvironmental Science seems destined to remain the custody of an 'invisible college' of academics, environmentalists and ecofeminists, operating within the present society, but outside its dominant paradigm. Establishment of courses in Ecoenvironmental Science is unlikely, both in the present social climate, and in the framework of the existing paradigm, but the ideas can be introduced, and no doubt are being so, in the context of the 'soft' parts of existing Environmental science programmes, where in fact they have been present since the beginning. In any case, the process of transition to the new age, if it ever takes place, will not involve piecemeal measures, but a shift which will transform radically all existing institutions, including those of higher education. If that ever happens, the distinction between Art and Science will have disappeared, along with many other trappings of Baconian-Cartesian thought.

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THE POLITICAL ECONOMY OF ENVIRONMENTAL CONFLICT

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INTRODUCTION

The political economy of environmental conflict sports a jejune literature. In particular, little is written at the two important theoretical levels of analysis in political economy, namely mode of production and transitions between modes of production. This paper outlines the broad debates within political economy and, using energy case studies, draws out inferences about the political nature of environmental issues.

POLITICAL ECONOMIC TRADITIONS

Malthus, Ricardo, Marx and Rousseau represent four traditions of interpretation of the political economy of capitalism as the transition to capitalism accelerated (Harvey, 1974).

Malthus, who offered a guarded welcome to the newly-emergent industrial bourgeoisie, was concerned to indicate that the viability of capitalism depended upon its production of high-value commodities which would not be available for mass consumption. Consequently, the emergent industrial bourgeoisie would have to target a particular group - the land-owning aristocracy - if capitalism was to secure a sustainable future. By attempting to demonstrate the geometrical growth in population outstripped the arithmetical growth in resources, Malthus hoped to dismiss the mass of the population from consideration.

Ricardo and Marx both welcomed the advent of capitalism but there were differences in the political direction in which they sought to drive the capitalist movement. Ricardo celebrated the rise of the industrial bourgeoisie not least because it removed the leaden hand of feudal aristocracy from trade and commerce. The rise of markets and the emergence of capital accumulation allowed the violent overthrough of older economic relationships. Marx, whose economic work was based on a critique of Ricardo's political economy, welcomed capitalism not so much for the development of the industrial bourgeoisie but for the abolition of drudgery associated with pre-capitalist production. Marx identified the engine for capital accumulation as the extraction of surplus value from workers. His political economy was therefore designed to allow the development of individual freedom for workers, through a collective action against capital that would parallel the freedom enjoyed by those who owned capital.

Rousseau rejected capitalism. For him, progress was not necessarily a 'good thing': change had gone on for too long. He celebrated the value and the tradition of small-scale, decentralised peasant production. In many senses, Rousseau and, to a lesser extent, Malthus looked backwards while Ricardo and Marx looked forward. The debates in which they ware engaged, however, were abandoned because of the very nature of capitalist development. The separation of the economic from the political sphere, notably because of the rise of universal suffrage in social bourgeois democracy, isolated politics from economic activity. Clearly, capital relationships were still determinants in the political order although the linkages were disguised. Moreover, the development of economics as an independent discipline, increasingly turned to the problems of the management of capitalism rather than a theory of capitalist development. In particular, the rise of marginalist analysis, in the late 1980's, heralded the separation of micro-economics and macro-economics. The former, especially in the guise of project-appraisal still dominates the discussion of environmental resources.

In the search for a theory of the political economy of environment it is not suprising that these four classical positions should re-emerge. Neo-Malthusians, neo-Ricardians, neo-Marxists and neo-Rousseauvians abound. Hardin (1968) represents the neo-Malthusians. They focus strongly upon the issues of population and have been re-inforced by the emergence of socio-biology. The neo-Ricardians (a catch-all phrase to cover bourgeois economics) is exemplified by the work of Dasgupta (1982). It generally supports the expansion of resource exploitation although some commentators temper their discussion with debates on the economics of regulation. The neo-Marxists have yet to present a coherent overview, although Smith (1984), following the tradition of classical Marxism, has produced the most seminal work. Their literature, analysing the problem as the product of the rush to procure exchange values rather than use values, provides a powerful critique by refusing to accept that environmental degradation is a consequence of the externalities of capitalist production and by insisting that such pollution is intrinsic to capitalism. Finally, the neo-Rousseauvians also do not have a dominant commentator, although Bookchin (1971) can be taken as an example. They are frequently identifed with the 'hippie' movement and focus on self-reliant and self-sustaining communities. Their critiques, not suprisingly, emphasise an alternative ecological future. Central to this future is an alternative energy vision.

ENERGY AS A CASE STUDY OF ENVIRONMENTAL CONFLICT

On energy futures there are three important levels of political debate. First, there is a critical debate on the form of future society, especially the degree of centralisation or de-centralisation in that society. Secondly, there is a debate about technology - ultimately about people's control of their environment. Third, there is a debate about location of production and reproduction frequently seen as 'not in my backyard'. This is the most frequent form of

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environmental conflict.

The Sizewell Inquiry, which investigated the building of a pressurised water reactor in southern England and into a longer-term Government commitment to that specific technology illustrates the contrasting viewpoints of the four traditions. The United Kingdom does not at present have a coherent energy policy. Consequently, it is not surprising that the Inquiry has generated discussion between protagonists and antagonists on nuclear technology.

The neo-Malthusians, perhaps best exemplified by the Council for the Preservation of Rural England, do not wish to see a power station in the idyllic landscape of south-eact England. Their objections, like their objections to the siting of a third London airport in southern England, have a political base which owes much to the traditions of the landed gentry. Their natural allies in political opposition to the building of the Sizewell plant are the neo-Rousseauvians best represented by the Friends of the Earth, who have tried to widen the debate to include issues of national energy policy and the evaluation of alternative technologies.

Against them are the Central Electricity Generating Board (CEGB) which embrace a neo-Ricardian position, and the Electricians' Union (EEPTU) - representing workers' interests - might be considered the neo-Marxist platform even though it is a right-wing union. However, the coal workers' union (the NUM), a substantially radical union, is opposed to an expansion of nuclear power because it threatens the coal workers' position as the single largest workforce in UK electricity production. Unions, in general, have played a defensive rather than a revolutionary role in British politics. The NUM, for example, is against nuclear power but not against large-scale electricity generation. The point to be made here, however, is that the unions embrace capital and drive for high technology in such energy disputes, whereas the political forces ranged against them, namely the neo-Malthusians and the neo-Ricardians, hold a political alliance against such developments.

The political alliances are fragile and arise usually only in single-issue campaigns. The more natural alliance under capitalism, the neo-Malthusians with the neo-Ricardians, is reflected in the conservative nature of south-east England in general and of the Council for the Preservation of Rural England in particular.

The changing alliances between broad groups, depending on whether the issue is seen primarily as political or economic, reflects the separation of politics from economy under capitalism. Such a separation reinforces the difficulties of articulating an adequate theory of the political economy of environmental conflict. Smith (1984) has begun constructing a political economy of nature. He argues that the concept of nature harbours an essential dualism between nature as external (science) and nature as universal (art). These two conceptions of nature are both interrelated and mutually contradictory. Without an external nature there is no need to stress the universality of nature. Under the capitalist production process, the externalisation of nature, like the externalisation of labour is essential to production. But such a conception provides only a segment of the portrait of nature, not least because such an external vision cannot explain human society in nature. The romantic tradition, which emerged from transcendentalist experience in the arts, is required to redress this balance.

Smith argues that under capitalism nature is essentially produced. The civilising influence of capital, much applauded by Ricardo and Marx, was to globalise social production so that all earlier periods appeared merely as eras of constrained local development. The transformation of the environment by capital is a universal process. Even if nature were to survive in pristine conditions, it can do so only because it is inaccessible to people. The production of nature implies social accessibility. Inaccessible nature, for example geological sub-strata, is essentially an ideal, an abstract of our imagination.

The external view of nature is loosely linked to a scientific, reductionist viewpoint where it is assumed that through analysis, universally applicable principles of resource exploitation can emerge. It assumes that because an external view is objective, knowledge that emerges from such enquiries will be free from class interests: knowledge can be trusted. The critical method of reductionism is through mathematics and the scientific/external view is frequently measured by how well mathematics are used in argument.

A major problem with such an approach is the assumption that, throughout history, societies have remained relatively unaltered. Under precapitalist societies, governed by nature idolatry, social organisation had to reflect the power of natural laws. With the advent of capitalism, the law of capital accumulation itself frequently provides ground for dismissing such laws. For example, in the debate on energy futures, much attention has been given to the possibilities of energy conservation. It is frequently cheaper to save a unit of energy than to produce a new one. The social organisation of capital, however, and its attendant laws of accumulation, force the abandonment of such principles. In other words it can be said that the laws of capital accumulation are stronger than the laws of thermo-dynamics.

The production of nature argument implies that other non-capitalist forms of production will have a different relationship with nature. For example, in the Third World, household energy use dominates total energy consumption. Most of the energy consumed is from wood, obtained as a use value not an exchange value. Additionally, most energy is consumed in an open fire, which again is not a commodity form. In attempting to address the energy problem in the Third World, many commentators noted the relative inefficiency of the open fire. They have sought to improve its efficiency by applying modern design technologies to building an efficient household stove. The problem with the diffusion of such stoves are, in many ways, insuperable, if stoves are not to become commodities. Traditional stoves not only allow for a power range in the household, covering boiling and simmering, but also serve a variety of other end-use functions, including lighting. The provision of an improved stove, on modern design principles, leads to the containment of the combustion space. Such containment precludes simultaneous end-uses. In contrast, in the modern capitalist world, household energy needs are not to be specific fuel technology combinations, e.g. gas cooking and electric boiling, where both fuel and technologies are commodities. Commoditization in the Third World, however, would increase demand for different forms of energy, particularly for the provision of light.

CONCLUSION

Against a background of political economy, therefore, there are three major problems in environmental politics.

1. Within capitalism, the political alliances on environmental issues do not match the broad economic alliances observable throughout capitalist society. This is part of the continuing disfunction of the political and economic systems under capitalism.

2. Capitalism produces nature to such an extent that it can abandon, with a relative degree of impunity, the nature of physical laws.

3. Because each mode of production has its specific relationship to nature, examination of the transition between modes of production might offer great insight into the problems associated with environment.

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POSITIVIST AND POLITICAL APPROACHES TO THE ENVIRONMENT : THE NECESSARY TENSION IN ENVIRONMENTAL STUDIES

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INTRODUCTION

In discussing the nature of the environmental idea O'Riordan and Turner (1983) offer a classification of environmental ideologies. The crucial distinction is between the ecocentrics and the technocentrics. The former stress the importance of communion with nature, the latter group includes the environmental managers who believe that the development of tools and techniques of environmental control can balance continued resource exploitation and economic growth with environmental protection. While few environmental studies courses will be untouched by the spirit of ecocentrics like Ralph Waldo Emerson it is equally true that the demands of modern education, along with the strong connections that exist between environmental science and environmental studies, will mean that few such courses will fail to identify their teaching programmes with what O'Riordan and Turner identify as:

> "... a new variety of environmental manager..., one who seeks to compromise (not always a middle ground) between the demands of creating more wealth and the need to safeguard against risk, environmental damage, loss of scenic heritage and unacceptable disruption to the way of life of various subcultures. The modern specialist is steadily equipping himself with an interdisciplinary training to various degrees. Within a decade most planners will have to be familiar with the intricacies of environmental impact appraisal, most nuclear physicists with the complexities of designing systems that are incapable of being upsurped by terrorists, and most engineers with a basic understanding of ecology."

Thus some form of technocentism is the order of the day within most environmental studies courses. At the extreme this can be associated with a positivist faith that,

> "... scientific and technical expertise provide the basic foundation for advice on matters pertaining to economic growth, public health and safety."
> [O'Riordan and Turner, 1983]

But equally, (and still operating within a largely technocratic framework which is optimistic about the role of scientific and technical knowledge in ameliorating the worst effects of economic growth) an alternative approach to environmental issues can be identified and is labelled in this paper as 'political'. This need not be identified with what O'Riordan and Turner refer to as the 'socialist-marxist' view which "... will accept nothing less than major political reforms ... ". Rather it is an essentially pluralist approach which concentrates on the actors in the policy process and on the connections between their interests and their actions. This paper discusses both positivist and political approaches to the environment, arguing that either can provide a framework which will co-ordinate disciplinary inputs in the analysis of environmental issues, and suggests that, despite the tensions that will inevitably arise, both are necessary in a course of environmental studies.

POSITIVISM, INTERDISCIPLINARITY AND MANAGERIALISM

Serious students of environmental issues generally accept that an interdisciplinary scientific analysis of environmental problems can and should be sought, and that the results of this analysis will permit the satisfactory management of the environment.

The very idea of interdisciplinarity is by no means clear cut. [OECD, 1972; Nuffield Foundation, 1977]. Peston (1978) offers a clear and interesting account of an interdisciplinary methodology. The essence of Peston's approach is that we should be sensitive to the implicit practice and that we should use other disciplines to explore these assumptions. Peston illustrates this methodology by discussing the case of two power stations which are similar in design but different in performance due to external influences rather than internal engineering.

Morphet (1981) has offered a critique of Peston's approach which argues tht the links between disciplinary contributions will seldom be straightforward or mechanistic, and that interdisciplinarity will in fact demand the creative generation of higher level (or meta-) theories to bridge disciplinary practice. (The term meta-theory is not an elegant one but it is a convenient label for the co-ordinating framework which must explicitly or implicitly unite disciplines in an interdisciplinary synthesis). Such meta-theories will (where they exist) be more-or-less specific to particular problem areas. Thus there is no unique basis for interdisciplinarity, each interdisciplinary synthesis will demand creative generation and will (like a discipline itself) direct analysis in an inevitably partial way. In time such interdisciplines can become recognised both intellectually and institutionally as disciplines in their own right

The intention of the present paper is not to argue against a positivist interdisciplinary interpretation of environmental studies. Cost-benefit analysis provides an illustration of the positive achievement of such an approach in co-ordinating contributions from a variety of disciplines - behavioural sciences, technologies, etc. But cost-benefit analysis is not without its critics (see O'Riordan and Turner, 1983, section 3) and the nature of the criticism illustrates the point made about the partiality of such interdisciplinary practice.

A POLITICAL APPROACH TO INTERDISCIPLINARITY

What is of concern in this paper is the question of whether such an essentially positivist schema should be seen as the dominant model in environmental education. To suggest that it should be is to pay dues to many accepted canons of academic practice. It is to defer to the primacy of knowledge and the power of the Baconian ideal. It is to be 'scientific' with all the associated virtues of communalism, universality, organised scepticism and disinterestedness proposed by Merton (1963).

But it is also to share something of the utopianism present in both Bacon and Merton. Were we to visibly achieve powerful and consensual analysis on this basis, and were successful managerial action to be the eventual outcome, then our faith might not be misplaced. But how much evidence can be brought forward to support this faith? And are we not in danger of paying the price of all utopianists and denying ourselves (in this case perhaps) improved water quality today while we search (scientifically) for the Arcadian springs.

An alternative approach to interdisciplinarity (which might formally be seen as a special case of the structure suggested above - with some sort of political structure providing meta-theory) recognises that most environmentally significant outcomes are not the result of Policy (with a large-P) based on interdisciplinary analysis. They are however the result of what might be termed 'policy' (de-facto policy with a small-p): the result of formal and informal negotiations between competing interests carried out against a background of legislation and control, itself a product of negotiation. And, significantly, this 'policy' process - which determines for example the quantities of airborne effluent discharged from some installation and the consequent quality of the atmosphere - is an interdisciplinary process in that a variety of disciplinary contributions are made. There are analyses of ambient concentrations of airborne material of mortalities and health risks; of technical possibilities of pollution control and their likely costs; of the profitability effects or employment consequences of possible legislation; of the local or national political impact of the same legislation. The process is of course a competitive one and not a consensual one; in all other respects it accords with the definition of interdisciplinarity offered by the OECD (1972):

> "An interdisciplinary group consists of persons trained in different fields of knowledge (disciplines) with different concepts, methods, and data and terms organised into a common effort on a common problem with continuous inter-communication among the participants from different disiplines."

To study the environment in an interdisciplinary fashion from this perspective is to replace the positivists concern with how the world 'ought' to be conducted with a concern with how the world is in fact arranged. Indeed Peston (1978) comes close to such a reformulation of his principally positivist stand in his discussion of the case of pollution.

Where the political approach to interdisciplinarity departs significantly from the positivist approach is in its necessary treatment of the status of disciplinary inputs. The positivist approach must, by virtue of its basic premises, commit itself to particular forms of disciplinary analysis. The political approach will, in contrast, maintain a scepticism about the validity and objectivity of disciplinary inputs to the policy process; indeed it will find of particular interest those areas of science where there is no consensus and where experts disagree (Barnes and Edge, 1982, part 5). A political interdisciplinarity will find it necessary to study the processes by which consensus is normally arrived at in science, to be aware of the uncertainties and limitations inherent in the acquisition of new scientific and technical knowledge and to recognise those areas where particular interests (however benevolently deployed) can shape and mould the nature of evidence offered.

It will also be necessary to recognise that the interdisciplinary organising framework is in significant part an institutional one, and that institutional frameworks are thus capable of mediating disciplinary inputs and of co-determining policy. And thus the results of a political analysis of interdisciplinary practice in these terms is neither positivist nor all-embracing. It is essentially a non-neutral, partial, critical, interventionist activity. But then so is the 'policy' process.

EDUCATION IN ENVIRONMENTAL STUDIES

What, then, are the implications for environmental education? It is generally acknowledged that environmental education must be 'interdisciplinary' but the nature of that interdisciplinarity may rarely be articulated. What is clearly insufficient is a juxta-position of disciplines with a nod in the direction of a problem focus: the chemistry of the environment plus the economics of the environment plus the politics of the environment does not of itself constitute interdisciplinarity. It may in fact constitute multi-disciplinarity, but given the competing arguments which may be presented by disciplinary specialists it is likely to be, educationally, at best incoherent and at worst confusing.

To attempt a coherent interdisciplinary approach is therefore to pose a challenge which is at one intellectual and institutional. Disciplinary autonomy is likely to be threatened when disciplinary contributions have to be subordinated to some co-ordinating framework of interdisciplinarity. Even the positivist approach to interdisciplinarity will demand that the selection of taught material from within a discipline will depend on external (meta-theoretical) criteria and not on the internal criteria with which disciplinary specialists will feel more comfortable. Course committees may ask for a particular type of chemistry or economics course but may well get a 'standard' introduction to chemistry of economics. Moreover, the political approach to interdisciplinarity can appear even more subversive to disciplinary practitioners: core material can be seen to undermine the foundations on which disciplinary practice is built, to ask questions which normal science has learned to make progress by ignoring, to introduce issues of social and political interest into the choice not just of technologies and research programmes but of scientific beliefs themselves.

Institutional structures inevitably militate against the easy surmouting of these intellectual obstacles. To stand outside science and criticise some of its practices is not to deny its vital importance and contribution to environmental protection; similarly to practice positivist science is not to be blinded to social and political realities. But the sort of cross-disciplinary respect that is necessary is not easily engendered between groups of people who are geographically separate and whose most frequent mode of communication is the indirect one of shared students.

Few environmental studies courses can have succeeded without some attempt to perform the sorts of social, intellectual and institutional syntheses outlined above. Two alternative routes present themselves, and the choice depends on the style of interdisciplinarity that is given priority. The positivist approach will arrange a course which might be called 'environmental management'. It will essentially provide meta-theory (or meta-theories) by teaching the sorts of planning and management tools which constitute one set of positivist approaches to the environment. Cost benefit analysis is but one such tool, others include technology assessment and environmental impact assessment. The latter includes a variety of techniques (Clark et al, 1978) which are likely to be elaborated as the EEC directive on the Environmental Assessment of Projects begins to come into effect (European Report, 1985).

The political approach will demand a comparable teaching programme. Here some sort of political sociology of science and technology must underpin the programme, and this will need to be formally taught. But perhaps the most appropriate teaching device is the methodologically modest one of the case study in which students can be led to see something of the nature of conflicting environmental interest and of the fascinating process of its resolution. Such case studies are a valuable teaching resource and environmental studies can continue to benefit from their generation.

In attempting to elaborate two contrasting approaches to the interdisciplinary study of the environment - the positivist and the political - this paper might have been expected to take sides and to advocate the supremacy of one over the other, it is perhaps important to recognise that both elements are necessary in environmental studies. The positivist approach must be taught because it exists, and because it promises real achievement. But it must be accepted with caution. Students must be familiar with management tools, and should recognise that they can on occasion provide significant environmental benefit. Equally, they should be aware that techniques such as environmental impact analysis are used as constituents elements in a struggle with and over nature: as tools of advocacy in political adversary process rather than as tools of analysis in consensual one. Thus the political approach to interdisciplinarity must be taught too.

The above discussion has emphasised the variety of different intellectual styles which environmental studies must straddle. To do this successfully, and to maintain cross-disciplinary respect and co-operation, is a major challenge that an environmental studies course will face. The tension between positivist and political modes is an inevitable and necessary one, best accommodated if the principles of this tension can be elaborated and discussed openly. This paper has attempted to make a contribution to the necessary discussion.

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The Role of Esthetics in Environmental Education

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"What happened to the idea of beauty in environmental education?" The predecessors of environmental education, such as nature study and conservation, frequently appealed to the idea of natural beauty in their efforts to gain support for the establishment of national parks and wilderness areas in the United States. (Huth, 1957). As late as 1965, President Johnson convened a White House Conference on Natural Beauty (1965) which was followed by many state conferences (Zube, 1975, p. viii). And the National Environmental Policy Act of 1969 (Public Law 91-190) asserted that it was the responsibility of the federal government to assure all Americans "safe, healthful, productive, and esthetically and culturally pleasing surroundings ...."

A cursory examination of environmental literature indicates that while esthetics is sometimes mentioned in connection with environmental education, as in environmental impact outlines, it is far more commonly ignored. Not one issue of the Journal of Environmental Education, which began publication in the same year as enactment of the Environmental Policy Act (1969), includes an article explicitly dealing with environmental esthetics or beauty. Nor is esthetics or beauty included in teacher guides (Gallagher, 1975) or environmental symposia (Hughes, 1977). To find significant treatment of esthetics it is necessary to turn from the construct of environment to that of landscape (Hallberg, 1980; Smardon et al., 1981; Zube, 1975) a concept familiar to both geographers and architects.

Both the constructs environment and landscape are anthropocentric and imply the presence of a human participant, and are sometimes used synonymously (Meinig, 1971). But generally speaking, there is a divergence in content focus: environment, notwithstanding the etymology, relates more closely to ecology (e.g. Hewitt and Hare, 1973) while landscape has more affinity for the built environment, geography and local history (e.g. Hoskins, 1970). This type of compartmentalization also extends to environmental values; while Leopold (1949) is often eulogized for his ethics, little consideration is given to the fact that his moral imperative, like that of Ruskin, was derivative from an esthetics of nature.

Perhaps environmental education should revive the idea of nature, which has a long identity with ethics, esthetics and art, the three complementary, and, in the nineteenth century, not regarded as hostile. Three individuals have been selected to personify the relation between esthetics and nature: Alexander von Humboldt (1769-1859) the foremost scientist of his age, was the last of the Renaissance men; John Ruskin (1819-1900) was the leading art critic of his age who turned social reformer; and John Dewey (1859-1952) was a philosopher and critic. They did not influence one another, but drew their ideas of esthetics and nature from the great revolution in thought which Shaftesbury heralded in religion and Rousseau in philosophy. By the middle of the nineteenth century landscape painting had become the dominant art form (Clark, 1969) and landscape imagery a stock form of the Victorian novel (McCarthy, 1970).

ALEXANDER VON HUMBOLDT

The major source for Alexander von Humboldt's presentation of the esthetics of nature is Cosmos (1855). In the introduction to volume one, he reaffirms the canon of the nineteenth century naturalist that there is a harmony and unity in the diversity of phenomena, "one great whole .... animated by the breath of life." (I, 24). This great system is not only to be understood intellectually, a sentiment not to be restricted to the delineation of prosaic fact but to be "vividly delineated by thought in exalted forms of speech, worthy of bearing witness to the majesty and greatness of creation." (I, 23) Nineteenth century scientists were in complete harmony with the Psalmist view. "The heavens declare the glory of God and the firnament showeth his handiwork." (Ps. 19:1). The discovery of the laws which governed the universe thus was a general type of beauty, the beauty of science, which transcended the limits of human existence and united man to an existential infinity, whether in the starry vault of heaven, the far reaching plan, or the vast expanse of ocean. The general sentiment of beauty in an intellectual system was complemented by beauty of the specific, which could range from the dreary barrenness of far-reaching steppes to fields rich with harvests (I, 25). Contemplation of nature thus evoked two types of beauty - the beauty of plan and "Science as the labour of the mind applied to nature." (I, 76).

Literary and artistic "Incitements to the study of nature" comprise the first part of Cosmos II. Humboldt's literary review anticipated Glacken's Traces on the Rhodian Shore (1967) and his eulogies of the French landscapists Claude Lorraine and Nicolas Poussin help us to understand why the Claudian ideal had such a long and persistent impact on American (Novak, 1980) as well as English landscape preferences (Lowenthal and Prince, 1965). Humboldt makes it clear that the study of poetry and prose and the admiration of painting was not a substitute for scientific knowledge, but stimulated a love for the study of nature, especially in the formative years of childhood. While Humboldt favoured a poetic sensitivity to nature, such as demonstratd by Wordsworth and Shelley, he decried the attempt in Germany, especially by Hegel and Schelling, to substitute an intuitive for a scientific study of nature. To counteract this tendency he undertook a series of popular lectures on nature in 1827-28, after his return from Paris to Berlin (Botting, 1973, p.232). Humboldt's idea that art could be used to further an appreciation of nature was influential on the American painter Frederick Church, whose large panoramas were in Humboldt's words, "calculated to raise the felling of admiration for nature" (II, 98). They still elicit not only respect for the artist but also his conceptualisation of nature (Stebbins, Troyen, and Fairbrother, 1983), a central idea in the thought of our next exemplar.

JOHN RUSKIN

Admiration for nature was the motivating force in the art criticism of our second mentor, John Ruskin. His *Modern Painters*, originally conceived as a defense of J. M. W. Turner, is deceptively entitled as an "encyclopaedia of natural observation," (Clark, 1969, p. 285). Atmosphere, animals, cliffs, clouds, lichens, mist, mountains, rocks, sea, storms, torrents, water, waves - all come under his appreciative eye. *Modern painters* is thus a text on the appreciation of nature as much as art and was influential long after Ruskin had turned from art to social criticism. The central message of Ruskin, reiterated in *The Stones of Venice* and the *Seven Lamps of Architecture,* was that the artist should study nature first, and not, as Reynolds recommended, take a short cut by first studying art (*Modern Paintersm* III, 25).

While *Modern Painters*, (1888) is Ruskin's magnum opus, a much more intimate and personal idea of Ruskin's nature esthetics is given in his autobiography, *Praeterita* (1885-9) written at Brantwood in the Lake District in his declining years. From his earliest years, Ruskin avowed an eager and methodic "thirst for visible fact" (*P*, p. 42), a trait which involved him in observing, "with closest attention' (p. 50) not only phenomena of nature but men in their daily work. And all such observations - pool, pebble, lawn, lake, canal, col, sun, sand, mist, meadow - went into his notebook, sketched and described. Many of these early observations were so thorough that whole parts were subsequently included in *Modern Painters*. In this day, when recording is done so quickly by the click of a reflex camera, it is difficult to appreciate the close attention Ruskin gave to nature. Here is a selection dealing with grass:

> On fine days, when the grass was dry, I used to lie down on it and draw the blades as they grew, with the ground herbage of buttercup or hawkweed mixed among them, until every square foot of.meadow, or mossy bank, became an infinite picture and possession to me, and the grace and adjustment to each other of growing leaves, a subject of more curious interest to me than the composition of any painter's masterpiece. The love of complexity and quantity before notices as influencing my preference of flamboyant to purer architecture, was here satisfied, without qualifying sense of wasted labour, by what I felt to be the constant working of Omnipotent kindness in the fabric of the food-giving tissues of the earth ..... (*P*, p. 397).

Such experiences gave him not merely a new appreciation of the relationship of natural phenomena to ornament, which he extolled in his essays and lectures on flamboyant Gothic, but gave him a new and deeper insight into nature. After hours of leisurely drawing branches near Fontainbleau, then intensely as he discovered new patterns of beauty and relationship, he records that this drawing experience gave his a new insight:

> Not silvan only. The woods, which I had only looked on as wilderness, fulfilled I then saw, in their beauty, the same laws which guided the clouds, divided the light, and balanced the wave. 'He hath made everything beautiful in his time', became for me thenceforward the interpretation of the bond between the human mind and all visible things; and I returned along the wood-road feeling that it had led me far; Farther than ever fancy had reached, or theodolite measured.
> (*P*, p. 285).

This love of nature Ruskin described as a passion, a feeling in which he loved "a stone for a stone's sake, a cloud for a cloud's. He was attracted by "wild ... places, especially to scenery animated by streams, or by the sea." (*P*, p. 205). He should have included mountains, to which he devoted the entire fourth volume of *Modern Painters*, or more precisely, the Alps, the first sight of which "had been to be as a direct revelation of the benevolent will of creation." (*P*, p. 261). This passionate view of nature led him to write about nature poetically rather than scientifically, though he once lamented that his interest in art had made England lose a good geologist. Thus overy forty years after his 1841 visit to Naples, which he especially disliked because of social conditions, he could recall "the snows and Alpine rose of Lauterbrunnen" as "visible Paradise" and contrast the ash and lava of cloud-crowned Versuvius as "visible Hell." (*P*, p. 261-262).

With this personal introduction from the *Praeterita*, the pronouncements in *Modern Painters* sound less dogmatic; they reflect a long and deep personal experience of nature. He is thus in harmony with Constable and anticipated Dewey when he wrote "The picture which is looked to for an interpretation of nature is invaluable, but the picture which is taken as a substitute for nature had better be burned; ..... "(*Modern Painters*, I, xv). While today beauty is more likely to be defined as a cultural attribute, Ruskin followed Burke and Hutcheson in which he wrote that ideas of beauty are derived from immediate perception of nature, in which "everything ... is more or less beautiful." (MP I, p. 27). The first task of the artist is to study nature in its infinite variety, from the grand sweep of the sky with its different forms of clouds and graduations of light (I, pp. 201-261), to the small details of buds and leaves (V, pp. 1-105). The young artist "should go to Nature in all singleness of heart, and walk with her laboriously and trustingly, having no other thought than to penetrate her meaning .... (I, p. 417). The vivacious but empty vitality of the descriptive landscape should be replaced with "reflexive" landscapes which are both "impressive and didactic." (I, p. 418). Thus the artist does not engage in art for art's sake, but for the message that he can transmit to the viewer, transforming the spectator into a participant in the sublime processes of nature.

As the years went by, Ruskin became more and more concerned about what was happening to his beloved nature and the tendency of man to substitute a false art for a true appreciation of nature. Both of the following selections are taken from his introduction to the Queen of the Air, written while he was in Switzerland (1869). In the first, he comments on the pollution of Lake Geneva:

> This first day of May, 1869, I am writing where my work was begun thirty-five years ago, within sight of the snows of the higher Alps. In that half of the permitted life of man, I have seen strange evil brought upon every scene that I best loved, or tried to make beloved by others. The light which once flushed those pali summits with its rose at dawn, and purple at sunset, is now umbered and faint; the air which once inlaid the clefts of all their golden crags with azure is now defiled with languid coils of smoke, belched from worse than volcanic fires; their very glacier waves are ebbing, and their snows fading, as if Hell had breathed on them; the waters that once sank at their feet into crystalline rest are now dimmed and foul, from deep to deep and shore to shore. These are no careless words - they are accurately - horribly true. I know what the Swiss lakes were; no pool of Alpine fountain at its source was clearer. This morning, on the lake of Geneva, at half a mile from the beach, I could scarcely see my oar-blade a fathom deep.

This second selection is a continuing paragraph, but here he contrasts the destruction of a patch of soapwort and the erection of'a fountain as a difference between appreciation of the beautiful and the false.

> The light, the air, the waters, all defiled!. How of the earth itself? Take this one fact for the type of honour done by the modern Swiss to the earth of his native land. There used to be a little rock at the end of the avenue by the port of Neuchatel; there, the last marble of the foot of Jura, sloping to the blue water, and (at this time of the year), covered with bright pink tufts of Saponaria. I went, three days since to gather a blossom at the place. The goodly native rock and its flowers were covered with the dust and refuse of the town; but, in the middle of the avenue, was a newly-constructed artificial rockery, with a fountain twisted through a spinning spout, and an inscription on one of its loose-tumbled stones, -
>
> 'Aux Botanistes,
> Le club Jurassique.'
>
> (Works, 19, 293-294).

His introduction to Queen of the Air closes with an accusation that modern science has released on the world Asmodeus, the evil spirit of destruction, and calls on Athena to restore to mankind a simple knowledge of nature - Air for Life, Rain for thirst, Fire for warmth, and the Earth for meat and rest. Time will not permit an examination of the pilgrimmage of Ruskin from art critic to environmental and social critic, as in Fors Clavigera. From the few selections given Ruskin makes clear my point - that an esthetic appreciation of nature makes us aware more keenly the degradation of the world in which we live. Esthetic sensitivity is not a sufficient condition to develop a moral responsibility to the environment and it may not be even a necessary condition, but nature esthetics and the experience of environment are closely related, as John Dewey emphasises.

JOHN DEWEY

John Dewey is significant for environment education because he emphasized in the twentieth century what Pestalozzi attempted in the nineteenth century and what Rousseau had introduced in the eighteenth - the centrality of experience for learning (Dewey, 1916), a conception which he transferred to esthetics in Art as Experience (1934). He shared with Ruskin the view that an esthetic understanding begins with an understanding of the ordinary world and its forces. He repudiated the academic approach to esthetics, beginning with the study of museum painting, and said "To understand the esthetic in its ultimate and approved forms, one must begin with it in the raw; in the events and scenes that hold the attentive eye and ear of man, arousing interest and affording him enjoyment as he looks and listens." Museum art was divorced from experience; gallery paintings were offered as objects of adulation rather than a source of esthetic experience with the normal processes of living. (Art, p.10). Dewey quotes with approval Cezanne who said "The louvre is a good book to consult, but it is only an intermediary. The diversity of the scenes of nature is the real prodigious study to be undertaken.'". (Art, p. 312).

One of his contributions in Art as Experience was to distinguish between perception and criticism, criticism as evaluation, and criticism as judicial enquiry. Perception supplies material, while criticism is the exercise of judgement. (p. 298). To perceive, the beholder must be actively involved, intellectually appreciating as well as enjoying his surroundings. Any meaningful esthetic theory involves two primary considerations: that as an animal, man has to make "the same basic adjustments to air, climate, light, plants, and energy as do other animals;" the corollary is "that life goes on in an environment ... through interaction with it." (p. 13). Art is the transmitted experience of a civilization (p. 327), but all arts have a common source - "the interaction of a live creature with his surroundings." (p. 317). Thus while Dewey never uses the concepts of ecology or ecosystem, the tenor of his thought is favourable to this way of looking at man in the environment, which provides the material for criticism.

Dewey rejected formula esthetic evaluation, and insisted that each individual, as a result of his direct experiences, make his own judgements. Esthetic discrimination emerges only when a person becomes conscious of the rhythms and patterns of nature. In contrast, the typical approach to esthetics was similar to judicial enquiry: it assumed an accepted body of rules against which a work of art was to be judged and a verdict returned. Since most consumers of art have given little thought to the bases of their perceptions, they turn to the expert. Having acquired this passive trait, the art consumer prefers to be told what to believe rather than exercise independent judgement. The result was not esthetic appreciation "but arbitrary conceit, fantasy and stereotyped convention." (pp. 151-152).

The concluding chapter of Art as Experience discusses the relationship of art and morals, a connection, according to Dewey, too infrequently made because of the tendency to associate public morality with economic and political institutions. This compartmentalization of esthetics and morality reflects an all too common tendency to isolate imagination from action, to separate emotion from decision making. The following passage, which includes a beginning line from Shelley, Dewey said, got at the "heart of the matter".

> "'The imagination is the great instrument of moral good.'.. It is more or less a common-place to say that a person's ideas and treatment of his fellows are dependent upon his power to put himself imaginatively in their place. Except where 'ideal' is used in conventional deference of sentimental reverie, the ideal factors in every moral outlook and human loyalty are imaginative. The historic alliance of religion and art has its roots in this common quality. Hence, it is that art is more moral than moralities ... Art is a mode of prediction not found in charts and statistics, and it insinuates possibilities of human relations not found in rule and percept, admonition and administration." (Art, pp 348-349).

Thus the extent to which environment education neglects in its design esthetic awareness, the weaker the consequences may be for environmental action: it will have neglected a strong motive force, making man both more conscious and caring of his environment.

EDUCATIONAL IMPLICATIONS

It is appropriate to make some practical application of the esthetic messages of Humboldt, Ruskin and Dewey to environmental education today. Despite differences in language, there is a common emphasis - to see the beauty in nature it is first necessary to study nature. The first recommendation, then is to engage learners in direct encounters with the environment, to study nature in the raw, to use Dewey's words. This recommendation may be less applicable to countries, such as England, where field teaching is a common practice in many areas of the curriculum, but it is badly needed in countries such as the United States and India where environmental education all too often remains bookish or becomes abstract. The direct study of nature, it should be remembered, is required by the discovery method of learning, new not in method but in terminology.

The second recommendation is that in the study of the environment, the concept of beauty should be introduced directly, and not obscured under such ambiguities as quality of life or cultural elements. Esthetics is concerned with the beautiful, but it is not likely that the beautiful will become part of our thinking unless the term becomes part of our lexicon. The study of a wet land as an ecosystem does not preclude us from seeing the beauty of patterns of light on water, the gradations in colour and texture of plants, or the changing forms in a cloudy sky. The study of a fault line does not keep us from seeing the beauty of fields and forest, the different colours of soil, or the silhouette of farm buildings against the horizon.

Of course, students who become interested in environmental esthetics may take courses in art, philosophy, or landscape architecture, but most such courses are designed to meet a narrow professional rather than a general esthetic interest. So I would prefer that an individual find his way to a conception of the esthetics of nature, rather than to be told authoritatively what to believe. In a real quest, there are many guides that can assist, from poetry, prose and painting. Our perceptions of environmenta are shaped by rearing and culture (Novak, 1980; Tuan, 1977) and training in environmental esthetics will undoubtedly heighten sensitivity (Meinig, 1971; Lowenthal and Prince, 1964, 1965). But a guide is only helpful to a traveller disposed to see, and esthetic considerations can hardly influence an environmentalist concerned with positivistic explanations. If Spate could embrace geography with such a sense of enjoyment, it is because he already approached geography with the disposition of Thomas Hardy "Let me enjoy ... " (Spate, 1966).

An esthetic approach to the environment is no substitute for science: deadly *Giardia* lurk in the snow-fed streams in the meadows above the rain forests on the Olympic peninsula; the smile of beauty can be deadly. But esthetic awareness can stimulate and then illuminate a scientific understanding. After years of exploration in the Himalayas, Younghusband (1920) asked if perhaps a knowledge of the "awful beauty of its terrific gorges and stupendous heights" might be the knowledge most worth having. And if we look for it, we do not have to travel far: we will find beauty in our own backyard.

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INTERNATIONAL CONTEXT OF ENVIRONMENTAL EDUCATION AT THE TERTIARY LEVEL

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INTRODUCTION : BIOSPHERE AND HUMAN DESTINY

There is already a considerable body of literature on the international context of environmental education (e.g. Caldwell, 1972; Farvar and Milton, 1972; Nicholson, 1970; singer, 1975; Sioli, 1973) and some reviews on the subject (e.g. Furtado, 1976). This paper will focus therefore on some contemporary international issues pertinent to environmental education. Although education also includes training in specific skills, trades and professions, publicity and propaganda, I will focus in this paper on issues pertaining to environmental education in the sense of enhancing the knowledge, wisdom, general competence or desirable qualities (intelligence, values or sensibilities) of human individuals especially through formal mechanisms at the tertiary level.

The evolution of the human species over the past three million years or more has been progressive on the basis of his biological attributes, especially his large brain, intelligence, upright posture, omnivory, pre-adaptation to a wide range of ecological habitats and climates, long infancy, learning abilities, maternal bonds, kinship patterns and social organisation (e.g. Sauer, 1971). This progressive evolution has depended on innovations in technology to solve contemporary problems such as the colonization of new environments and the exploitation of new resources, and the transmission of these technological innovations to other individuals and generations through the cultural process.

It has involved the transformation of the human species from one integrated with natural ecotopes (or ecosystems) to one modifying natural ecotopes (or eco-systems) and creating synthetic ones. In this transformation, every social unit (e.g. family, community, tribe, nation) of the human species found it necessary to evaluate the economic potential of its immediate environment, and to organise itself around this environmental potential both in terms of its own techno-cultural skills and the values it accepted. Thus, even traditional primitive societies possessed some rudimentary understanding of the international (though not global) environmental context.

Although the human species has transformed the natural environment since the dawn of history, only fairly recently has this transformation been significant both in technological intensity and global extent. Openness to new ideas both from within and without since the Renaissance, development of increasingly efficient technologies since the Industrial Revolution, rapid and mass communication of new ideas and technologies since the invention of the printing press, and mass migrations of human communities to new and remote lands as a consequence of better health care and transportation and population growth, have all contributed to the intensive and extensive transformation of natural resources with its international and global environmental consequences (e.g. Caldwell, 1972). This transformation occurred along models of progressive economic growth for the European or advanced countries (e.g. Rostow, 1960), reinforced by a Protestant Christian ethic (e.g. Eisenstadt, 1968), which demanded increasing energy subsidies, materials consumption, administrative and political organisation, and colonisation or subjugation of other human societies (e.g. Manners, 1964). The institutions and values of this era prevail today, even in the politically-independent and less advanced countries, leading to imbalances in resource transformation and management, abuse of common property resources, breakdowns in the equitable distribution of benefits, and confrontations between the rich and the poor, the urban and the rural societies, and the advanced and the developing nations. The less advanced nations are confronted with harsh socio-biological realities for development:

1. Low levels of natural resources, capital and technologies per capitum.
2. Low levels of resource production per unit of human effort.
3. Low prices per unit of resource produced.
4. Low wages per unit of human effort.
5. Low levels of health and education per capitum.
6. Poor infrastructure for gaining access to technology and capital and monitoring labour.
7. Artificial national boundaries for the resource-partitioning interests of the advanced countries.
8. Internal political tensions on perceptions and approaches to resource utilisation and environmental conservation for social and national development.
9. Low levels of consumption of resources per capitum.
10. High levels of population density and growth rates.

It is evident from the above considerations, that the human species is confronted with one colossal global phenomenon - the management of social and technological change. This phenomenon demands imaginative approaches for the diversified and sustainable use of international politics and understanding focused on the problems of man, his survival, happiness and personal fulfilment, at the individual, national and global levels (e.g. Huxley, 1971; Illich, 1973). For the less advanced countries, in particular, it demands specific and unique national strategies for generating and achieving national scientific and technological development (e.g. Alatas, 1972; Wilson, 1971) as well as global interdependence. The constraits to this overall achievement appear to be in the rate of acquisition of technological capabilities to intervene in regional and global ecological processes, and in the lag in understanding of techno-cultural and resource transformations and of psycho-social processes for managing change more effectively (McHale and Cordell, 1974).

Under these circumstances, what sort of international dimensions can I suggest for environmental education? This paper argues that, since the biosphere is one system and human destiny is intertwined with it:

- Resource management and environmental conservation depend on adaptive technology.
- Science and its application for technological development are essential for environmental education at the tertiary level.
- Universities have a vital role as ivory towers, frontier posts and service stations in resource and environmental research and education; and need revitialisation especially in the less advanced countries.
- International co-operation is a sine qua non for the transfer of science, technology and developmental models, and for revitalising universities, among tertiary institutions, and for striving for global interdependence, through both governmental and non-governmental mechanisms.

SCIENCE AND TECHNOLOGY

The acquisition of technological capabilities for transforming resources and the environment, intervening in ecological processes and enhancing psycho-social organisation, depends on the nurturing of science and its application for resource utilisation and environmental conservation. Practical and field experiences, including an experimental approach wherever possible, are invaluable for productive scientific and technological insights. While the scientific and practical approach flourishes in the advanced countries, it is less successful in several less advanced countries and institutions generally for the lack of one or more of the following factors: an open and receptive cultural environment; the commitment of individual scientists; scientific leadership; competent scientists and technicians; multidisciplinary teamwork with an interdisciplinary goal; adequate equipment and facilities;

imaginative identification of environmental issues and development of field experiments; and adequate political and financial commitment. Since science is universal, scientists and technologists from the advanced countries can be helpful in addressing these issues by promoting environmental education in the less advanced countries, thereby building international networks which are essential for the advancement of science and of environmental understanding.

Although the biosphere is one super ecological system, having evolved structurally and functionally as a whole, a global perspective rarely emerges from several tertiary programmes in environmental sciences especially in the less advanced countries, for the same reasons as outlined above. Programmes in environmental education usually revolve around one of three foci: awareness about environment and resources; ecosystems, ecological processes, public health, environmental engineering and resource ecology; and human ecology, environmental planning and techno-cultural interventions of the biosphere. Programmes in environmental and resource awareness, though useful for public education, do not usually embody a scientific approach and they are sometimes alarmist. As such, they are more conducive perhaps for the non-formal education sector than the formal. Where they have been introduced at the tertiary level, as they have in some universities in Asia, they appear to produce an informed graduate or activist, though not necessarily one competent in tackling and resolving environmental and resource issues.

Programmes focused on ecosystems, ecological processes, public health, environmental engineering and resource ecology appear to have evolved from science-based departments at the tertiary level. They are usually soundly based in science but are limited often by a disciplinary or sectoral approach. Furthermore, they are unable usually to devote sufficient systematic attention to the consideration of techno-cultural interventions on natural resources and the environment. Since the biosphere is one ecosystem, these programmes could be enhanced not only through a multidisciplinary consideration of environment and resources, but also through a systematic introduction of techno-cultural interventions and considerations. Programmes focused on human ecology, environmental planning and techno-cultural interventions of the biosphere are founded usually in the social sciences. They are sometimes disciplinary or sectoral in their approach, somewhat weak in science and technology, and unable usually to devote sufficient systematic attention to the consideration of the biophysical aspects of resources and the environment. These programmes could be enhanced through better integration of their biophysical and socio-cultural content.

In view of the oneness of the biosphere, the structural and functional similarities within biomes in different geographical locations, and the similarity and pervasivness of techno-cultural interventions, sharing of developmental experiences in different geographical locations could enhance and has enchanced the quality of environmental or resource education programmes, besides promoting the integration of natural sciences with the social sciences and humanities and a multidisciplinary approach to an interdisciplinary focus. Such approaches are somewhat weak in the less advanced countries, for which advanced country institutions may have an invaluable role.

ROLE OF UNIVERSITIES IN PARTICULAR AMONG TERTIARY INSTITUTIONS

Universities have been the catalysts for social and technological change and development since their monastic roots, especially after the Renaissance.

They served traditionally as 'ivory towers' preserving cultural heritage, as 'frontier posts' pushing forward into unknown intellectual territory, and as 'service stations' providing society with learned recruits (Ashworth 1985). They have been displaced in much of their ivory tower role largely by libraries, museums, galleries and the like, especially in the advanced countries. In their frontier post and service station roles, universities in the advanced countries appear better developed than their counterparts in the less advanced countries with respect to environmental education. The reasons for this appear to be the same as those for the development of science and technology. Furthermore, universities in the less advanced countries appear to be functioning largely as teaching institutions with little or no research to reinforce their teaching content and stimulate undergraduate students; and this is reflected equally in the environmental and resource arena. As a consequence, many of their students who are seriously interested in environmental sciences and resource management, have had to transfer to advanced country universities or tertiary institutions for remedial training before undertaking postgraduate studies. Since environmental and resource studies can flourish around critical contemporary issues in any setting, there is considerable scope for inter-university collaboration, as pioneered by the University of Malaya - University of Aberdeen scheme or, as pursued by Dalhousie University with Indonesian universities, to explore innovative approaches in education. Such a collaboration could broaden the basis for enlightened opinion and responsible conduct on environmental and resource issues pertaining to development, both nationally and internationally, by focussing on research and education pertaining especially to resource production and environmental conservation. It would revitalize the role of universities especially in the less advanced countries, which is urgently required if we wish to move forward globally.

INTERNATIONAL CO-OPERATION

International co-operation in one form or another has always spurned development. In the context of environmental conservation and resource management, this co-operation should be fostered both formally and informally at the governmental and non-governmental levels. Opportunities for international co-operation have already been identified in terms of the natural and social science aspects of resource management and environmental conservation, and in terms of the role of universities in environmental education. Such co-operation can be pursued through various mechanisms, such as:

- UNESCO's Man and Biosphere (MAB) Programme
- ICSU's Biosphere-Geosphere Programme
- IUBS's Decade of the Tropics Programme

International co-operation in natural sciences has been most successful through non-governmental mechanisms, such as in the International Biological Programme (IBP). Since environmental conservation and resource management involve both natural and social science issues pertaining to development, international co-operation needs to be fostered through both governmental and non-governmental mechanisms, and must harness the involvement of capable committed individuals.

For those of you from the United Kingdom, it may be worthwhile to note that the British Government has suggested an international environmental programme for Commonwealth co-operation. The details of this are unclear. Nevertheless, there should be scope for exploring intersectoral (industry-university-government) international interaction.

The Commonwealth Secretariat and the Commonwealth Science Council are embarking on co-operative research and training programmes pertaining to natural resources, coastal zone and ocean management and may become involved in environmental education programmes. The Commonwealth Science Council's programme was developed by an Expert Group led by Sir John Kendrew, FRS, Nobel Laureate. It is entitled "Science for Technology for Development", and envisages co-operation projects embodying issues in natural resources, new technological aids and science management and organisation. These programmes are designed to enhance local developmental capability through appropriate training including research.

Institutions like the United Nations University and the Association of Commonwealth Universities, promote inter-university collaboration. There is considerable scope for international co-operation research and education through non-governmental bodies such as your own Institution of Environmental Sciences or the Commonwealth Human Ecology Council.

CONCLUSION

The international context of environmetnal education is innate in the nature of the biosphere, science, universities and of human destiny. International co-operation can enhance resource management and environmental conservation for human development in innovative ways, as suggested by Thomas Jefferson:

> "Laws and institutions must go hand in hand with the progress of the human mind. As that becomes more developed, more enlightened, as new discoveries are made, new truths disclosed, and manners and opinions change with the change of circumstances, institutions must advance also, and keep pace with the time".

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THE WORLD CONSERVATION STRATEGY AND ENVIRONMENTAL EDUCATION

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THE STRATEGY

The World Conservation Strategy (WCS) was launched in 1980 by the International Union for the Conservation of Nature and Natural Resources (IUCN) following two years or more or consultation and discussion among its member organisations, with the support of the UN Environment Programme and the World Wildlife Fund and in collaboration with UNESCO and FAO. Its case for conservation was based on three main objectives - the maintenance of essential ecological processes and life support systems, the preservation of genetic diversity and the achievement of sustainable utilisation of species and ecosystems for development. In addition to the wide-ranging exchanges through which it was assembled its special significance lay in three characteristics:

i) the comprehensive nature of its review of the environmental challenges facing humankind in stewardship of the planet;

ii) its status as a strategy for action rather than reaction i.e. not merely to repair damage but to design the future;

iii) its recognition of the role of man in the system to be conserved and of the need for sustainable development of resources to secure the quality of human life.

It thus emerged as a statement of authority, realism and importance, acknowledge by the prestigious launching ceremonies which it was then accorded by heads of state or senior ministers in 34 countries.

As a global statement it was necessarily couched in rather general terms, and the need was made plain for a further stage of national strategies adapting its principles to the particular conditions of individual countries. The UK gave a strong lead in this by publication of the UK Conservation and Development Programme (the UK CDP) in 1983, and others have either been produced or are on the way. Many other documents have been published to translate the ideas of WCS into languages and terms accessible to a wider readership. A further stage should follow in which subnational and specialised organisations and institutions use the stragegies as guidelines for their own forward planning, e.g. the Welsh response (Jones, 1982) and the Nature Conservancy Councils's Conservation Plan (1984).

The UK CDP offered a valuable model for a national strategy in an industrialized country. It extended WCS aims for UK action into three broad areas - integration of conservation of living and non-living resources with development, the establishment of a sustainable society in which both physical and psychological needs are met, and the development of a stable and sustainable economy through practices of resource conservation in all spheres of activity. Its recommendations were discussed and presented under the separate headings of rural, urban, industrial and marine environments, overseas environmental policy, education and ethics. An overview report picked out those proposals on which rapid action was deemed to be possible. One proposal, at least, has been realised - the establishment in London of a Centre for Economic and Environmental Development charged to pursue the other recommendations in the Report.

In some respects WCS was incomplete. It had little to say about population problems although this has now been separately addressed by IUCN (1984) and must become a major element in any educational response. It was also criticised for dodging the politics of scarcity. But for those engaged in environmental education WCS and its succeeding documents now offer a rich quarry of material and the broadest consensus yet of the measures necessary to save the world from ecological breakdown.

WCS AND EDUCATION

It was recognised in WCS that to achieve its aims new behaviours and attitudes would be required among people, consistent with a new environmental ethic. It was also recognised that the main obstacles to attainment of sustainable development lie in the attractivenss to both public and policy-makers of measures which offer quick and tangible rewards within the life of one administration, rather than long-term security. The strategy stressed the need for greater public involvement in decisions affecting conservation and development, and the need for this to be better informed by educational programmes which clearly demonstrate the importance of an ecologically sound environment to such sensitive human concerns as health, welfare and living standards. While stragegy documents, both global and national, also recommended ways of promoting conservation through education, there is a growing opinion that a more specific educational stragegy will be needed if the objectives of the conservation strategies are to be achieved. The following are among the reasons.

i) As a conservation document WCS could not be expected to give as much attention to educational needs and structures as to conservation ones, but this attention is necessary if the two are to combine in a common enterprise. Educationalists do not regard themselves simply as the purveyors of other peoples' prescriptions. Their first priority is to guide the development of environmentally competent subjects rather than to be information processors or propagandists (a distinction which some conservationists are reluctant to accept).

ii) Current educational activities in this field, although growing in number and variety, remain unco-ordinated, unrelated, often episodic and haphazard. Where they should strengthen each other by a collective purpose they may even weaken each other by fragmentation (especially in the eyes of administrators in the formal sector) and by repetitive emphasis of popular themes. Environmental education is promoted by many different kinds of group interests which do not necessarily accept conservation objectives as their main structuring influence: conservation interests must therefore work to make and keep their place in an interdisciplinary process. A strategy thus needs to provide a broad statement of aims and objectives and an internal conceptual structure (comparable with that already provided for conservation) to which the (desirable) diversity of outlook and activites can be related.

iii) Continuous pressure is needed if this kind of education is to reach all its target audiences, especially some influential ones whose formal education is apt to be determined by conservative examination requirements. In the formal sector these problems of status spill over into the education of many other young people who would like to attain similar status (but do not). Balancing relevance against status leads into political minefields, but it would be unwise to leave all the work to other sources of influence: a conservation strategy with its policies well founded in ecological principles might well justify a claim that its particular recipes provide the best menu.

iv) WCS objectives are unlikely to be reached by minor tinkering with subject syllabuses, producing materials and mounting special campaigns, important and valuable as all of these are. WCS requires a realignment of educational philosophy. Adjustment of behaviour also calls for action beyond the limits of formal and informal education to improve the environment of education itself. This has been likened to opening Pandora's box and is no task for the timid, but there is little use in pretending that the necessary changes are less than comprehensive. A message of this sort needs all the authority it can get.

INGREDIENTS FOR AN EDUCATION STRATEGY IN THE FORMAL SECTOR

An education strategy will require much help from the Tertiary Education sector and what follows is an attempt to identify some important ways in which this might be given, with special reference to some of the discussions in which the IUCN Commission on Education has recently participated.

i) An Identity

The global strategy for conservation is based on a perception of the earth and its biosphere that has become steadily more familiar in the public mind since the first space photographs of the planet. The popular use of phrases like 'spaceship earth' emphasize its unity, its isolation in the universe and its finite resources, rather than the old ideas of limitless wealth sustaining a stage set for the performance of Man. Backing the public image and gaining some poularity are a growing number of writings directed to a non-specialist readership, by scientists who attempt to take a holistic view of the global system - Lovelock's 'Gaia' hypothesis (1979), is an obvious example. Ecologists now deal broadly with the process which determine structure and change in ecological systems - see for example the work summarised by Rapport et al, (1985) on the ecological effects of stress, with its implications for the effects of humankind on the world, and the analyses of human systems based on energy relationships offered by Odum and Odum (1981). These are examples among many studies and texts which seek to identify the main structural components of the system of which we are a part, as guides to the means by which malfunction may be diagnosed and treated.

The hard core for research and thought on which such accounts are based is nevertheless still undertaken within departments and institutions of much more restricted subject definitions, and will probably continue to be so. Such traditionally separate disciplines do not always work easily together, especially as one moves from the sciences to the social sciences and the arts, whose role in the interpretation of human behaviour within the system is vital. There is, for example, an important place for philosophers and theologians who may well be justified in regarding as naive some of the attempts of scientists to apply wider meanings to their findings.

Of course environmental education is by nature interdisciplinary. Acknowledging the continuing importance of subject departments as the source of hard core research and scholarship, there is still a great need for the various types of cross-disciplinary groups, of which examples now exist in many tertiary institutions, to be accorded more importance in funding and in academic status. These need not of course be confined within one institution: they may extend e.g. to other academic institutions, research stations and industrial concerns.

Perhaps the greatest service that a consortium of academics could do for environmental education at the present time would be to build for it a model of the main structures and processes which characterise man-environment relationships, in a sufficiently skeletal form to allow its use as a means of defining what enviornmental education deals with. This is a question which still greatly confuses educational administrators and curriculum developers. In one sense there is now too much semi-popular literature on the subject, from too many points of view, and the result can be bewilderment. To give form to the subject matter of environmental education, with an authority to match that of the traditional disciplines, would be a special service to the advancement of education.

ii) The Development of People in their Environment

At the heart of environmental education lies the reappraisal of man's relationship with his environment, a recognition that organism and environment are not primary and secondary in their relations but the two interlocking parts of a single system. The complexities of the relationship between the parts have also been the subject of ecological theory (see, for example, Patten, 1982), and have implications for the design of learning strategies which again call for interdisciplinary study.

The development of environmental experience of the environment extends through life from the familiar to the less familiar, and may be roughly classified in terms of the spatial environment of physical and biological components, the social environment, the temporal environment and also the internal environment of physiological and mental processes (Smyth, 1977 1983). Education should provide a balanced extension of this experience beyond the limits to which it might otherwise reach.

Many other influences, however, some in early life, are also involved in the shaping of attitudes. Furthermore, if the environment is under stress, and exhibiting the consequences of it, so are the people. WCS gives guidance on the former but much less on the latter. If attitudes and behaviour of people are to be modified it is necessary to know what determines their present behaviour. This will include the social and psychological consequences of stress, the various factors which determine how they perceive their environment, the reasons for the ways (often peculiar) in which they use it, the extent to which it is represented for them by the views of others and by such indirect experience as television, and so on. This is another field for expert guidance. It also has to be remembered that behaviour starts to develop as an interaction between nature and nurture during early pregnancy, that prenatal and perinatal events affect it and that some of the most potent influences are certainly not ones which would normally be termed education but yet are not irrelevant.

Out of all this grows the individual motivation on which educational success may depend. If it is to be guided by an environmental ethio, as WCS requires, then the differing interpretations of man-environment relationships offered by different religious systems must be understood. Already IUCN-supported studies of the influences on environmental education of cultural and ethical systems contained in the ethnic mix of some European cities, have exposed a rich seam of material for developing better understanding of a multicultural environment. Its implications as an enriching element in education extend world-wide. The truth is that the importance of these ideas goes far beyond the concept of environmental ethics to deep-seated motivations (see for example the separate contributions of Boyd and Skolinowski, (1984), to an IUCN Commission on Ecology symposium in Indonesia in 1982). Here again the tertiary sector of education could help by research and synthesis.

iii) Problems of Interpretation

One of the great concerns of professional environmentalists, when they view environmental education in schools and the non-formal sector, is the readiness with which ecologically complex issues which happen to have become matters of public concern - acid deposition might be an example - are treated superficially and given over-simplistic interpretations. This is a real dilemma: people respond most readily to issues which they can see touching themselves and their quality of life, but the ecological, social and economic complexities which underlie them may tax the wisdom of experts. One interesting suggestion made recently by Dunnet, (1985) is for the introduction of 'specially trained translators of ecological data to make sure research is widely understood and put to really effective every-day use'. If a place and funding could be found for such a service it could greatly improve the quality of education and training, and probably also assist practical conservationists to make the best use of ecological research.

The UK CDP recommended the establishment of a power base ideally developed round a university chair in environmental education, from which research and development could be promoted and organised. Such a development would help to take care of many of the needs mentioned here.

iv) A Place in the Curriculum

The introduction of environmental education into formal curricula - at any level - may be through the introduction of specific qualifying courses, through supplementary courses included as balancing elements, and through the modification of traditional courses to give them an environmental dimension.

(a) The first of these categories is exemplified by many courses developed in recent years either as clusters of related environmental subjects or as courses focussed on a particular aspect of environmental management (e.g. environmental health, environmental design, environmental law). So long as the products of these courses can find their way into forms of employment which make use of their experience,this is obviously to be encouraged. As the UK CDP points out, however, such courses are necessarily specialised and may not achieve the holistic view advocated for environmental education, nor do they contribute much to the development of an ethic. So these in themselves do not offer all that may be required of environmental education in the Higher sector. At a lower academic level there is also a case noted in the CDP for establishing full-time training schemes to produce scientific monitoring technicians, recognising a service that should be increasingly needed.

(b) Environmental education should, however, reach all branches of the intellectual community. 'Only when environmental education assumes a central place in all education will it begin to influence environmental management and policy' (Delhi Declaration, 1985). The need to provide future decision-makers (e.g. civil servants, local government officials, managers in industry and commerce, elected representatives, lawyers, trade union leaders) with an appreciation of environmental management and conservation has often been stressed, either by inclusion of environmental modules in relevant degree courses or by post-graduate or post-experience special studies. A similar need has been stressed for the education or training of 'environmental interviews' (e.g. architects, planners, designers, engineers, economists, public health workers, land agents, property developers). In a different form environmental issues should be part of the training of all teachers, both as a preparation for general education and as an aspect of special subject teaching. Such courses do, of course, occur widely, sometimes compulsory, often as options within a range of choices: the problem is that their status is apt to be seen as much inferior to that of the 'main' course elements. Only when the environmental education of these categories of people is accorded as important a place as the other components of their education, in relation to degree quality and employment prospects, will this kind of course fulfil the requirements of the strategy.

(c) To reach beyond these particular groups to the rest of the formal tertiary sector calls for modification, where possible, of traditional courses of study to ensure that the concept of man-environment interdependence, rather that superiority, is given its due place and environmental dimensions fully explored. To varying extents this applies even to many of the courses traditionally environmental e.g. biology, geology, geography, agriculture, forestry, and the often neglected environmental aspects of medical education - where long established practice may be difficult to move to make way for treatment of current issues.

v) Changing Needs

Conservative curricula are often the basis of a particular complaint from educators in developing countries. In theory new institutions in new countries should be well placed to develop new courses, issue-based and responsive to national needs, but in practice the colonial inheritance and the continuing prestige accorded to traditional institutions of the western world often militate against the efforts of reformers. The assumption of the superiority of western ideas and values has had unfortunate effects, not least in undervaluing the technical knowledge of rural people. Only now is the wisdom of e.g. traditional methods of husbandry and traditional uses of local plants beginning to be recognised. Higher education especially in the Third World must increasingly turn to rural traditions, rural locations and to the disadvantaged to seek the creative balance between modern science and traditional understanding from which sustainable development may be achieved (Chambers, 1985).

There is a particular need to integrate the teaching of conservation with that of development if the goal of sustainable development is to be understood, let alone achieved. At present they tend to reflect different, if not contraditory, interest and skills.

Change of practice on this scale is no small undertaking. It calls for a wide-ranging reconsideration by the academic community, and its clients and paymasters in government and industry, of which academic activities in the present world should be dignified by high status. A convincing case for WCS principles will have to be backed by convincing arguments and sound data which point to short term as well as long term benefits.

There is an important influence here exerted by the tertiary sector of education on the secondary sector. The education of children both at home and abroad has greatly changed, as western industrial society has attained its dominant position, but not necessarily in tune with changing needs (for a stimulating discussion of the changes see Goldsmith, 1974). In both developed and developing countries the attractiveness of subjects to school children and their parents is largely determined not by their relevance to everyday life but by their value as entry qualifications for universities and colleges. In parts of rural Africa even children with little prospect of academic advancement may scorn practical issue-based subjects relevant to their livelihood, in favour of more academic subjects.

There have, however, been promising experiments in the Third World, in the incorporation of environmental teaching into the main qualifying subjects of the curriculum, and these deserve to be extended (see, for example, Vulliamy, 1984). The merits of such changes must, however, be recognised by the tertiary institutions, which should also consider seriously the relationship of their entry qualifictions to the real educational needs of their prospective entrants and the much larger number of young people whose education will be swept along in the same stream.

Yet even if such recognition is accorded, and the perceptions change of what is appropriate education, the problems are still far from solved. Many questions remain as to what determines success or failure in transferring school-based learning to community behaviour. Many failures are a reminder that education is not independent of its social, cultural and economic environment and there is still much to be done to blend these effectivley. Nor is their solely a problem of the Third World as many teachers in this country know all too well.

OUTREACH PROGRAMMES

The tertiary sector or education extends its influence far beyond its walls through its leadership role in the organisation of conferences and seminars, through the work of Extra-mural and Adult Education departments, through its support of student organisations and through the work of many dedicated individuals who carry their academic skills and experience out to benefit the community at large. The following are only a few examples of the kind of activities which have been, or might be, of major benefit to the spread of environmental education.

(a) Of conferences there is no end, but a series of seminars on the World Conservation Strategy mounted in 1981 by Tufts University in Medford, Massachusetts, led by distinguished international experts and attended by both students and environmental professionals, represents a type of academic activity which would bear repetition elsewhere and geared to a wider variety of target audiences. This particular series, resulting in a book (Thibodeau and Field, 1984) was seen as a first step to bring WCS into an education setting.

(b) Adult education departments and others are becoming increasingly involved in Community Education. With the growth of unemployment and early retirement the potential constituency for such activities must be substantial. Given the commitment of planning authorities (in this country at least) to involve local residents in planning matters it would be a valuable exercise in both conservation and education to develop local community groups with a real job to do, as a focus for local learning centres and community information services concerned with environmental improvement (among other things), (see for example SEEC, in press).

(c) Related to this but operating perhaps in a different part of the community is the recent proposal made by the President of IUCN, Dr. Swaminathan, (1985), to institute a grid of local Conservation Clubs, on the model of Rotary Clubs, attracting members of the community with environmental concerns and some, at least, with influence. There already exist models of a related kind, for example,the remarkable IVN network in the Netherlands which is made up of community groups of interested members who carry out, voluntarily, a wide variety of mainly educational activities in their own areas. Enterprises of this sort are entitled to expect help and leadership from within the Tertiary sector.

(d) In the same speech Dr. Swaminathan proposed the formation of an international Eco-development Corps of young professionals backed by a global grid of advanced institutions able to supply technical help and training. Here both faculty and student body in the Tertiary sector would have key roles.

THE ENVIRONMENT OF EDUCATION

If the quality of the environment is so important to the quality of human life and activity this must apply to the environment in which education itself is conducted. This deserves much further study. Among features that might be rated highly in a sustainable environment are diversity as against monotony, quality as against quantity, balance as against growth, energy efficiency as against waste, adaptability as against conformity, local individuality as against uniformity, small stable social units as against large fluctuating ones, miniaturisation as against magnification, emphasis on manners and customs as against law, co-operation as against competition, pride in performance as against profit, personal as against impersonal relationships emphasis on long-term as against short-term benefit, provision for all as against only productive groups (cf. Odum and Odum, 1981). Overgeneralised and over simplified as such indicators may be,they should stimulate some critical thought as to the nature and policies of our own educational institutions. It takes little imagination to identify ways in which they would require modification if these generalisations have substance. Already we find parallels with such ideas in educational recommendations e.g. of Botkin et al, (1979) in their report to the Club of Rome. We may be sure that precepts of environmental quality may be unconvincing to our students if not accompanied by exemplary practice in those areas which we can control.

Considering again the probable influence on environmental attitudes of many components of the environment beyond our direct control - social, cultural, political, economic, governmental, press, television - this critical assessment might be carried much further for the ultimate benefit of the community at large.

CONCLUSIONS

The contribution to be made by the educational system to dissemination of the principles of the World Conservation Strategy are many and various. Mention has been made here of only a few of the ways in which the tertiary sector might contribute. In summary they are:

i) The continuing development in tertiary institutions of cross-disciplinary research schools or institutes to promote collaboration between separate schools, departments and related outside institutions;

ii) The creation of academic centres of excellence to promote research and development in environmental education at national level;

iii) The construction of a skeleton theoretical model of the man-environment system capable of serving as a conceptual core for the organisation of environment education;

iv) The construction of model of the development of environmental attitudes, as a guide to the design of a comprehensive education strategy;

v) the promotion of inter-cultural and other studies to establish the nature and qualities of environmental ethics, and the cultural and religious sources of motivation for behaviour towards the environment;

vi) The development of a service for the interpretation of ecological concepts and research for the benefit of practising educators and conservationists;

vii) The reinforcement of environmental components in the education of decision-makers, environmental interveners and others;

viii) The reinforcement in particular of education relating to sustainable utilisation of resources and sustainable development;

ix) The promotion of courses for environmental monitoring technicians to improve facilities for this service;

x) The reassessment of status accorded to particular subjects and to subject content in the context of academic and employment status and entrance to tertiary education;

xi) The further assessment of relationships between formal education and community behaviour;

xii) The promotion of extra-mural environmental education through such activities as seminars, community education, local organisations, international initiatives;

xiii) The critical appraisal of the quality of the environment of education itself, and of the many influences which impinge on it.

No doubt there will be many more.

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ENVIRONMENT MANAGEMENT EDUCATION: A MODEL FOR SUSTAINABLE NATURAL RESOURCES DEVELOPMENT

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INTRODUCTION

Global concern about environmental problems, quality of human life and the impact of development led to the convening of the United Nations Conference on the Environment in Stockholm, Sweden, in June of 1972. The recently concluded tenth anniversary of the Stockholm Conference stressed the need and role for environmental education (Bowman, M. L., 1972).

Recommendation 96 of the Stockholm Conference called for the establishment of an international programme in environmental education that would be interdisciplinary in approach, formal and non-formal, encompassing all levels of education and directed toward the general public.

In separate action, the U.S. Agency for International Development initiated a Title XII program that was designed to assist U.S. colleges and universities in the development of faculty expertise to conduct education, research and public service in relation to developing countries while improving the quality of education within the participating institution. The historic involvement of the United States with developing countries was continuing but was in growing need of additional trained faculty with interests in international work. A general ageing of participating faculty was occurring without the opportunity to train and interest younger faculty in international work.

Against this backdrop, the focus on resources, economics and the abilities of developing countries to cope with escalating problems was increasing. It can be concluded that essential environmental resources of developing countries are subjected to stresses of unprecedented magnitude and the health, nutrition and general well-being of large portions of the population are directly dependent on the integrity and productivity of these resources. Governmental ability to manage resources effectively over time may be the most important prerequisite to the eradication of poverty, the fulfillment of basic human needs, obtaining a quality life and the ultimate achievement of sustained development.

While the natural resources of most developing countries are being rapidly depleted by general deforestation, habitat destruction, desertification, soil erosion and the pressures of rapid population growth, government agency and non-government organization ability to educate and inform the people about the effective management of natural resources may be the most important prerequisite to achieving a quality life.

AN ENVIRONMENTAL MANAGEMENT EDUCATION MODEL

A model for the strengthening of developing countries' Environmental Education and Information capabilities for building an appropriate institutional framework to deal with conservation problems and sustainable renewable resource and energy development is presented. Examples from the Dominican Republic and Barbados will be discussed. Public environmental management education and training programs will be discussed in relation to the establishment of sound renewable resource management plans, developmental goals, and the establishment of an environmental ethic. Evaluative approaches are presented in relation to program and workshop effectiveness and knowledge gain and attitude shift in relation to selected environmental management and energy issues.

ENVIRONMENTAL MANAGEMENT EDUCATION DEFINED

Environmental management education is concerned with an individual's self understanding, an understanding of the co-inhabitants of the Earth, and interrelationships within and among each of these constellations of concern. A major goal is to encourage the individual to develop the ability to make thoughtful decisions which will create an environment that allows one to live a quality life. Specifically, environmental management education is concerned with developing a citizenry that is:

1. knowledgeable about the biophysical and sociocultural environments of which man is a part;

2. aware of environmental problems and management alternatives of use in solving those problems; and

3. motivated to act responsibly in developing diverse environments that are optimum for living a Quality life.

(Roth, P.E., 1969)

Thus it can be seen that environmental management education is concerned with knowledge of the universe, society, and the individual in that it not only attempts to provide the individual with environmental understandings, but also views one as a potential creative being and encourages acceptance of the responsibility for decision-making.

Another characteristic of environmental management education is that it deals with attitudes, the attitudes people hold about themselves, toward other individuals and groups of individuals, and toward their environment. These constellations of ideas greatly affect our level of living and quality of life.

Because environmental management education is not just ecology, resource-use, sociology, art appreciation, philosophy, or management, an interdisciplinary focus is required that embraces the sciences, humanities, social science, and technology for purposes of developing cognitive understanding, belief and attitude change, and providing motivation for behavioural change and effective action.

A first step towards an agreed upon body of concepts appropriate for environmental management education was taken when a list of 112 concepts was produced (Roth, R. E., 1969). Scholars from 40 professional areas and 12 ecological regions of the United States agreed on the majority of concepts to be emphasised. The concepts delineated represented a useful and appropriate structure of conservation concepts.

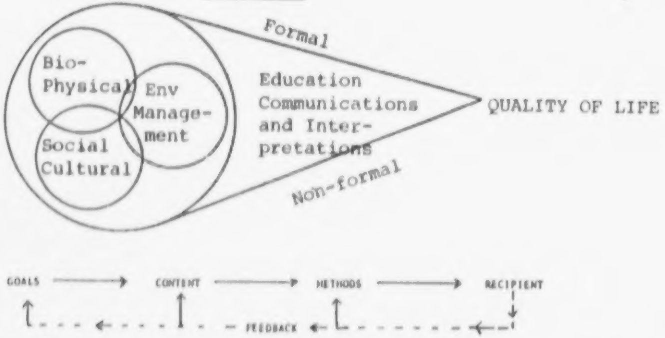
The list of 112 concepts was subsequently submitted to a panel of experts (Ohio State University personnel) representing the various disciplines, organized according to topic and arranged in the order of importance on the basis of Q-sort response. A consensus was reached both as to placement in a major area and as to degree of importance (Bowman, M. L., 1972).

The concepts important to know in environmental management education were grouped into four categories: Biophysical, Socio-cultural, Environmental Management, and Change. Each cluster of concepts is viewed as existing on a continuum and the four areas are represented as spheres on the following model. The four areas are considered to be interrelated. The conceptual core is applied through "Educational and Communication Processes" comprising a range from formal education to nonformal communication strategies. The major goal described on the right side of the model is "Quality of Life" which can also be interpreted as the individual's conception of achieving a workable Environmental Ethic.

The organization and validity of environmental management education concepts was deemed to be appropriate for program development and curriculum organization.

The proposed model has the advantage of being concise, graphic, and logical in its application. It provides an easily visualized guide to the process of program development in both formal and non-formal educational settings regardless of cultural and national context. The program developer is reminded that the identification of appropriate environmental management/education goals, objectives with a behavioural or measurable orientation, and well defined and implemented communications or teaching strategies are essential for achieving a "Quality Life." Feed-back of both a formative and summative nature are to be utilised in relation to impact on the reciptient or target audience. Through rigorous evaluation strategies involving pre and post testing of concepts and attitudes assessment of skills and performance, and the achievement of anticipated goals in documentable form, it will be possible to demonstrate achievement of intended goals in relation to the improvement of the "Quality of Life."

THE MODEL



(Roth, R. E., 1973)

Townsend, R. D., (1982) conducted an investigation into the underlying structure of the domain of environmental management education concepts. A refined list of 54 concepts drawn from the works mentioned above was submitted to a randomly selected panel of experts and practitioners in the field for a review of accuracy and validity for environmental management education. The underlying dimensions (factors) of the concepts studied were identified as: (1) Ecology: Interdependence and Living Things; (2) Culture: Interaction with Environmental Considerations; (3) Ethics: Human kind's Moral Responsibility for Environmental Considerations; (4) Natural Resources management and Use; and (5) Population: Interactions with Environmental Conservation. While differences in perceptions of concept catgories between this work and those proposed by Roth, R. E., (1969) and Bowman (1972) exist they can be explained by the general nature of the concepts which leaves them open to multiple categorization possibilities.

A DOMINICAN REPUBLIC EXAMPLE

The Dominican Republic's natural resource base is deteriorating at an alarming rate. As indicated in the recently completed Country Environmental Profile (CEP, 1981), erosion rates per hectare in most of the nation's watersheds are estimated to average 300 metric tons per year. Since erosion rates of between 10 and 30 metric tons per hectare are normally considered excessive, the erosion rates in the Dominican Republic are little short of catastrophic.

The massive destruction of the watershed areas is exhibited throughout the country. Every year millions of tons of the nation's most productive land base are washed away as hillside areas are denuded and covered with massive scars from landslides, washouts, and deforestation. The color of the rivers are now a bright brown indicating the increased soil loads in the water. Due to the lack of hillside vegetation cover, the unusually heavy rainfall from two hurricanes dumping 21 inches of rain in seven days has taken on calamitous proportions causing major flooding throughout the country. Sedimentation is filling up the nation's reservoirs. The useful lives of multi-million dollar hydro-electric facilities have already been cut to less than half by siltation. In addition, siltation damage to hydro-electric facilities often results in lower-than-planned power output levels and frequent power outages.

The hillside farmer is at the center of this problem. He is forced by population pressures to cultivate on the only land available: hillside areas which are highly vulnerable to erosion. The agricultural practices the farmer uses are often the principal cause of erosion which results in lower productivity, a major cause of his poverty. The hillside farmers are trapped in a vicious cycle which, unless broken, will result in increased destruction and increased suffering for the hillside poor.

Fortunately, the situation can still be reversed. The degradation of the country's watersheds can be brought under control before the point of irreversible environmental degradation is reached. Time is short, however. It is estimated that within 20 years, the landscape of Dominican side of the island will resemble that of its neighbor, Haiti.

The National Resources Management Project will assist the Dominican Republic in building an institutional framework to deal with the natural resources conservation problem. This project will form part of a broader USAID strategy which aims to have in place, during the decade, the necessary institutional capacity and field experiences to effectively confront the country's natural resource problems.

A major activity under this component will be the strengthening of the Dominican Republic environmental education program. Under this activity, the efforts to generate more public and target group awareness of the natural resource problem and ways to deal with it will be strengthened and expanded. Training workshops will also be carried out to teach school teachers, local leaders, and small framers to increase local participation in conservation activities. A viable approach to changing hillside farming behaviour patterns which can be replicated in other critical watersheds is the goal. It is expected that the project inputs and the spread effects from project activities will cause sufficient numbers of hillside farmers to implement improved conservation practices in order that stabilization of natural resource degradation can take place within a watershed, within the coming decade, and in a cost-effective manner.

Objectives of the Environmental Management Education Project in the Dominican Republic include the following:

1. Development of a comprehensive national plan for environmental education.

2. Development and testing of alternative communication techniques to strengthen awareness of resource issues.

3. Training of teachers, leaders and farmers in conservation concepts.

Specific inputs include:

1. Short courses for teachers, leaders and farmers.

2. 225 one-day workshops for farmers.

3. Purchasing of education equipment, electrical generators, buses and vehicles.

4. Development of a training centre at Jimenoa.

5. Providing three person-months of technical assistance.

6. Receiving four persons from SURENA to enroll in long-term training in environmental education and communications.

The Environmental Education component of the project utilizing the proposed model for Environmental Management Education is making significant progress both at the national as well as at the watershed levels. Posters, written bulletins, pamphlets, radio programs, T-shirts, bumper stickers and a video tape of the project have been prepared for the mass media program. Curricula for targetting specific concepts to grades 1-6 have been designed, although this goes beyond the original project activity. A number of short courses are being designed with different target groups in mind. Construction of the Jimenoa Training Center is nearing completion.

Evaluation of work completed to date reveals that the educational program appears to be major stimulator of interest in conservation practices. Prior to the project a study by the Office of Environmental Education revealed that only 40% of the campesinos used conservation practices like composting. A recent survey indicated more than 80% of the campesinos in the target water-sheds were utilising conservation practices. The program has been very active in organising courses and in participating in workshops/courses organised by other groups such as the Junta de Desarrollo. Success can be attributed to:

a) use of existing associations and committees to mount courses with farmer groups in different areas,

b) trainers knowledge of local people and ability to relate positively to their production as well as conservation concerns,

c) preexisting knowledge of conservation methods,

d) availability of transport and adequacy of materials,

e) willingness of personnel from other programs, including military units, to participate; and

f) support from the head-quarters staff in Santo Domingo and knowledge of importance of the program.

Initial evaluation of farmers' responses to the training programs indicates that there is more interest in specific conservation training than in general exposure to the concepts of environmental protection. Participants are highly receptive to hands-on demonstrations like composting and reforestation. Preliminary evaluation of school students, on the other hand reveals they are very responsive to more general concepts and to wildlife protection, but not as interested in agricultural conservation practices.

A further advantage of the training effort lies in the ability to relate concern for conservation with concern for production systems. If conservation techniques are treated and presented in isolation, farmers appear to be much less interested in their possible relevance to their situation than when practices like composting or building terraces are utilized as educational activities.

A BARBADAN EXAMPLE

The Caribbean is a region with 15 island nations with Barbados being one among the countries of the Eastern Caribbean with a strong dedication to education and enlightened management of her natural resources. The development of educational approaches have moved from a tentative involvement with innovation stressing such issues as discovery learning, child-oriented instruction, and scientific literacy to a positive Caribbean-controlled thrust involving science and technological education for national development.

A variety of educational models are described by King (1979) as being useful in achieving educational and national development. The motivation for curriculum development is derived from: the march to independence and other forms of internal self government sparked by a surge of nationalist feeling and dissatisfaction with colonialism; (2) the attempt to provide a type of education enriched both qualitatively and quantitatively to meet the new demands on society; (3) the need to produce a type of manpower in keeping with the technological demands being made on the system; and (4) the necessity to develop an enquiring people, with an eye on producing a scientifically literate citizenry.

Emphasis of the Environmental Management Education approach utilized in Barbados concentrated on science teachers in year one of the project and social studies teachers in the second year. The workshop goal was to utilize the proposed model to portray concepts related to international resources and environmental management education, and to train faculty for international development work.

The project in year two consisted of developing, implementing and evaluating a workshop for secondary social studies teachers in Barbados. Social studies in Barbadian schools is a composite of geography, history, economics and political science. The interdisciplinary nature of the curriculum lent itself well to providing opportunities to learn about the environment. Environmental education does not appear as a distinct subject in the schools of the island, but an integrated approach through the disciplines has been well worked.

Coordination of the workshop was accomplished by a representative of the Caribbean Conservation Association, with the assistance of the Barbados Community College and the Ministries of Education, Agriculture, and Housing and Lands. Twenty-seven teachers attended the three days of lectures, hands-on activities, development sessions and field trips. As a follow-up each teacher developed an activity that could be used in his or her current teaching situation, thus applying immediately what was gained from the workshop.

Informal evaluation of the experience revealed that teachers deeply appreciated U.S. involvement in this type of development. Participants left with a new excitement and a wider perspective of what instructional materials and techniques were effective for environmental education. Programs such as this benefit not only the teacher participants, but the OSU faculty who learn about international development, and the OSU students who may learn to think globally by association with those whose classroom is the world.

EVALUATION STRATEGIES

Evaluation strategies that would seem to be useful in assessing the effectiveness of the Environmental Management Education model are proposed below.

A determination of appropriate concepts and content is a useful first step. As indicated previously, the works of Roth (1969), Bowman (1972), and Townsend (1982), provide a sound basis for identification of concepts and providing an organizational structure for their presentation. As the conceptual organization was applied in the Dominican Republic and Barbados, it was possible to speculate on knowledge gained, some attitudes that may have been shifted and skills that were acquired and employed.

Subjective evaluation is another evolving strategy that was employed by a team of independent reviewers in the Dominican Republic Environmental Education portion of the Natural Resources Management (NARMA) project. Surveys previously conducted and those in progress indicate that conservation practices are being implemented as a result of project activity through the use of video-taped documentaries that provide observation of a visual change in the landscape. In addition, preliminary evidence of concept gain and attitude shift resulting from pre/post assessment of participants in the workshops and mass media campaigns exists and will provide the basis for more detailed and rigorous pre/post studies presently under design.

Fortner (1983) conducted a study to evaluate the environmental education program across the two cultures of Barbados and United States workshop participants by comparing teacher characteristics and adoptive potential of existing materials. It was found that both groups had positive attitudes toward teaching and responded enthusiastically to the varied techniques of the workshop activities. School curricular limitation were viewed to be restrictive for adoption in Barbados, but U.S. School Curricula were viewed to be more accommodating of materials adoption. The workshops in all cases appeared to achieve the intended objectives and pre/post test evaluations revealed an increased awareness of availability of materials, enhanced techniques, and motivation to adopt activities experienced.

SUMMARY

The proposed model for Environmental Management Education has been utilized in both the Spanish and English speaking Caribbean for the implementation of training and education programs. Concepts appropriate for the development and implementation of both conservation and environmental management education appear to be relevant. The variety of methodologies employed for the formal and non-formal education settings appear to be effective. The established goals and objectives of the program examples are being achieved as evidenced by the various preliminary evaluative strategies. It is suggested that the model for the development of either formal or non-formal environmental management/education programs in developed as well as developing countries.

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THE FRENCH CONNECTION:
ASPECTS OF CONSERVATION EDUCATION IN FRANCE

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INTRODUCTION

Over the last two decades there has been an enormous growth in public awareness of the need for conservation. This may be attested in any number of ways, not least by the growing number of groups and organisations, with their increasing memberships, which manifest concern for conservation by their manifold activities.

It is also evident that young people are in the vanguard of many conservation movements. Such increasing environmental awareness, especially in the younger age group, has a 'snowballing' effect and generates a growing desire by individuals, groups, communities, and organisations to learn more about their own or nearby environments. It also stimulates a desire to understand the idea of conservation management, or phrased another way, sustainable development, which should affect every decision taken concerning the use and management of land. Once stimulated and informed people have a desire to participate more actively in the making of decisions which affect the quality of their lives.

This increasing awareness has been reflected in a demand for conservation education which has been recognised by the competent authorities in most European countries (Activitats d'Educaio Ambiental, 1983). However, it is also increasingly realised that schools and colleges, despite their important role in this area, cannot, by themselves, cater for the growing and varied demands to educate and interpret for conservation. Thus, many countries in Europe have developed a certain dualism in the provision of conservation education in response to these demands with much instruction being provided outside the formal system but frequently in association with it, so that schools and colleges have the facility to 'plug into' another system which may provide a more appropriate training and thus a pedagogical advantage.

CONSERVATION EDUCATION IN FRANCE

Conservation management of the natural heritage, safeguarding and enhancing the environment and improving the quality of life imply a concerted, sensitive and continuing educational endeavour and the French Government has affirmed the inseparability of conservation education and environmental management (Fed.des PN Min de L'Ed Nationale, 1982). Recognising the wide spectrum of demand for conservation education, it has been French policy to work both through the formal educational system and through other structures which are perhaps more attuned to present policies aimed at decentralising decision-making and encouraging public dialogue and involvement. Basically there are three coalescing strategies which have been developed to accommodate conservation education: co-operation, training and interpretation.

CO-OPERATION

Since 1971 it has been recognised in France that conservation education could not be contained within the formal educational system or indeed within one ministry. In 1981 an inter-ministerial committee on the quality of life was set up (CIQV). This means that Education and other ministries involved directly in environmental matters, particularly Agriculture, the Interior, Leisure and Environment, co-operate and consult together and with many other interested parties on the formulation of environmental education programmes. Through the Committee funds are provided for a number of educational projects (PAE) which are carried out in co-operation with colleges, lycees and écoles normales, while the Committee also supports additional educational activites undertaken outside the formal system (Dossier 29, 1982). Co-operation also operates regionally, the Environmental and Youth and Sports Services in Lower Normandy and Brittany for instance, have co-operated in running courses to assist teachers and others in their task of countryside interpretation. While the Directorate of Architecture and Environment (DRAE), in the same regions, provide courses and discussion on a number of countryside management problems.

TRAINING

It has been recognised that standard teacher training programmes in the environmental field need to be augmented and geared more towards common environmental problems experienced in everyday life (for instance nature conservation, pollution control and environmental impact analysis) and reinvigorated with a sense of mission. Such improved training has now been established in nine regional centres and also at the Countryside Management School at Versailles and the European Institute of Ecology at Metz. In addition many Departments have established, often in conjunction with regional parks, environmental teaching/laboratory centres, in significant country locations, for use by their public schools. A new conservation dimension has also been given to the training of those whose job it is to manage the environment professionally - the countryside and water engineers and the foresters at their national school (ENGREF) and at the regional centres. Instruction is provided from a variety of sources within education and from outside from experimental educational centres belonging to the Ministry of Agriculture to courses organised by regional architectural and environmental delegates (DRAE). Concommitant with these developments has been the creation of a series of 'teaching supports' ranging from detailed research documents to audio-visual presentations.

INTERPRETATION

Interpretation may be described as a dynamic form of education involving as it does an intimate relationship between the person and what is being described (Beauchamps, P., 1983). In educational terms two particular structures, established in the seventies, are well-equipped in very different ways to provide environmental interpretation. They are residential environmental education centres (CPIE, les Centres Permanents d'Initiation a l'Environnement) and regional parks (PNR les Parcs Naturels Regionaux). There are twenty CPIEs and twenty-two PNRs; both are loosely grouped together (L'Union Nationale des CPIE) and (Federation des Parcs Naturels de France) for the purposes of promotion and to ensure a desirable degree of co-operation and co-ordination in the overall thrust of their policies.

CPIE

These residential centres are seen as an integral part of the overall national policy of conservation education (UNCPE, 1983). Their aim is to encourage young people particularly to learn about the environment by every means possible. Through pedagogical innovation in the development of a number of themes and activities they deliberately emphasise an interdisciplinary approach to the management of the environment. They are attuned to the present policies of decentralisation as they have been created on the initiative of the local population and it is the local people who benefit in the first instance. These Centres act as springboards for local initiatives in conservation education providing information dialogue and training. Their aim is primarily, although by no means exclusively, to bring all cateogries of young people, including those who are disabled and those from urban areas as well as those living locally, into direct contact with the countryside. This is achieved through interpretative education based on physical activites - canoeing, cycling, orienteering, walking - connected with 'access' to nature. It is also often based on work in small laboratories, on manual activites or in the traditional arts and crafts, or yet again by various means of expression and communiction such as aural histories, language and popular traditions. These activities are greatly facilitated by the provision of accommodation which permits those who are learning to become more involved and familiar with the environment.

These centres may be established near parks or reserves or in any environment, including urban areas, where there is a genuine interest in innovative education. Through their particular types of interpretation studies of the surrounding environment (etude du milieu) the CPIEs try to generate a true understanding of the relationship between man and his environment the better to enable the citizen to manage this patrimony.

NATURAL REGIONAL PARKS

The formation of a Natural Regional Park (PNR) in France is initiated through a request for a park from local people themselves in liaison with the various local and regional authorities. After public enquiries, and if their submission is successful at the national level, the park is established through the granting of a 'Charter' which lays down the geographical limits of the park and stipulates guidelines for its operation (Morineaux, 1982).

The fundamental objective of parks managements is to assist the social and economic development of the area while at the same time protecting the environment and enhancing the quality of life for the inhabitants of parks and their visitors. Such an integrative approach has evolved over the last eighteen years as parks have increasingly realised it is only by adopting such a stance that progress towards their objective can be achieved. Thus, for instance, the interpretation and appreciation of a park's natural or cultural heritage cannot be seen as 'apart from ' but as 'an integral element in' achieving its social and economic well being.

THE ROLE OF PARKS IN CONSERVATION EDUCATION

The educational policy of these parks may be summarised as fostering a sense of commitment from local communities and from visitors to the fundamental park objective of invigorating local enterprise while at the same time protecting the environment from abuse and neglect (Aitchison, 1984).

Educational policy is therefore concerned to promote an awareness of problems associated with countryside management and the needs of local communities in individual parks and to urge local people, together with their authorities, to participate in the future management of their countryside (Charte Constitutive, 1980). The encouragement of attitudes of awareness and participation depend on the careful nurturing of a deep knowledge and understanding of park environments, thus the 'fostering' and 'encluragin' role is seen as a vital part of parks' educational mission. This is discharged in a variety of ways which may be simply categorised as advice, research, interpretation and motivation, these categories should be regarded as flexible areas of activity rather than rigid functional divisions. A detailed table (Fig 1) shows how parks fulfil their educational role in practice and is based on an educational model for the Normandie-Maine Park.

With their wide-ranging and multifarious approach to the study and interpretation of the countryside, as well as providing for the special and technical needs of local communities, it can be seen that parks attach considerable importance to their educational role. This is especially so in the case of young people who will be tomorrow's citizens. In collaboration with formal education, from nursery to university, parks offer many programmes to assist students, both from within parks and from outside, to better under-

Broad Educational Objectives	Organisations co-operating with the Park	Educational Work of the Park	Examples of Educational Projects in the Park
Advice (liaison, information) ↑ ↓	Voluntary organisations, various Clubs, Groups and Federations and Collectives.	Co-ordination of nature conservation activities. Park briefings/debates Series of training courses for special interest groups. Publication of material. Promotional activities.	Organisation of local association for the collection of nature survey and census material. Fund raising for display. Mounting exhibitions in the park (e.g. by Assoc. Faune et Flore de l'Orne) Training courses for recognition as 'nature protectors' FQPN.
↑ ↓ Research (at all levels, dissemination of results) ↑ ↓	Universities, Higher and Professional Bodies and Institutes Research Centres Ecoles, Collèges and Lycées Départements and Régions, Other authorities (e.g. forestry: ONF CRPF), utilities and National Ministries (e.g. Education, Environment, Agriculture) Tourist organisations Chambers of Commerce	'Popular' reports for public information. Provision of research results for interested parties and organisations. Environmental evaluation programmes for conservation. Production of teaching aids and tools for all educational levels, including technical and agricultural. Use of results from research in framing/advising environmental protection policies. Advice on the development of sites and buildings.	'Pays de Bocages' a description of the NM park (PNRNM, Université de Caen, CNRS, etc) 'The Pedlar's Box', how to study woodland for schoolchildren (PNRNM DRAE). Studies on the genetic conservation of apple and pear species. Research on the acid peats in the Forest of Ecouves Ethnographic studies (e.g. rural roofing, the hemp industry). Site discovery pamphlet 'Saint-Ceneri-Le-Gerei researched by the fifth form of the Collège de Moulins-le-Carbonnel. 'Etude Paysagère (PNRNM CREGE) 'Circuit de Decouverte de la Forêt' ONF Uni de Caen CNRS AFFO PNRNM
↑ ↓ Interpretation (the value of the natural and cultural environment) ↑ ↓		Discovery programmes and the provision of park information for the public. Establishing and development of 'Interpretation Sites' (e.g. 'teaching orchards') - Maisons, Musées, Centres d'Initiation, Ecomusées etc. Interpretation - Vocational, technical and in continuing education. Special courses for researchers, teachers and students, and courses in collaboration with the formal education.	Interpretative exhibitions and park demonstrations at various centres (e.g. Maison de la Pomme et de la Poire at Barenton, Les Eaux "Vives et Dormantes" Exhibition at the Maison du Parc. Itinéraires d'Initiation a la Promenade - Découverte - at the Fosse-Arthour Orne Environmental documentation for Dépt de l'Orne - public works. 'Hedge Plantation and Improvement Practical Advice' (PNRNM, IDF, ETA) Environmental Awareness (PNRNM Works Dept.) Dép de Equip. d'Orne Self help programmes for farmers Advice on planting trees to preserve the character of the landscape. General Interest Classes on the Work of the Park 'Countryside Management and Recreation in a Small Settlement' (PNRNM)
↑ ↓ Motivation (interest in the environment through activities)	Youth and Sports services of the Départements and Régions Local clubs and groups (e.g. Orne footpath federation FOTR) Tourist organisations	Provision of 'base de plein air' with qualified instruction and practice in various physical/sporting activities. Cultural activities and participation in local festivals/spectacles. Development of discovery circuits.	Production of discovery pamphlets e.g. for cyclists (Circuit des Ducs) Canoeists (Randonnée Sur La Mayenne) tourists (La Ferrière aux Etangs) also for climbers and horseriders Canoe and Kayak training courses at Torchamp PNRNM DDJS MSM)

FIGURE 1 The Educational Model of Natural Regional Parks (based on on the PNR Normandie-Maine

stand their environments and to relate directly to problems associated with their management for conservation. Parks also attach an equal importance to offering educational stimulation to the wider community and to the community at leisure. They show people how to learn for themselves so that those who participate in increasing numbers may discover more about their own particular 'interest' environments, be they forest, chateau or river, and in doing so they may be lead to a wider appreciation and understanding for the park environment as a whole.

This outline indicates the very considerable role played by parks in conservation education. However, it should be noted that in France, as well as in Britain, the harsh economic climate makes it increasinly difficult for parks to fulfil their objectives as they would wish.

DISCUSSION

It can be appreciated that there have been very considerable developments in conservation education in France during the last fifteen years. In Britain too little attention has been given to these developments in France, and indeed to developments in Europe generally. Yet geographically, economically and socially we have far more in common with Europe and particularly France than we have with more distant parts of the world where we so assiduously focus our attention. This state of affairs arises in part from language difficulties which are frequently exaggerated. More seriously they arise from ingrained attitudes of a certain arrogance towards, and ignorance of, 'the continent', generated largely by the history of our 'Island Race'. This is unfortunate; however,there are signs of a changing attitude with membership of the Community and as our changing role in the world becomes more evident with successive generations. Hence environmental education in Britain is now more appropriately considered within the context of Community policies and particularly the approaches to environmental education in France, our nearest Community neighbour. In so many ways we share a common heritage and face many similar environmental problems; we should therefore be able to learn from the French experience.

One of the most important differences between the two countries, and from which others emanate, is the wider acceptance in France that education in the environment is not the preserve of the formal education system alone (Kingsbury, 1984). Indeed, for many aspects of conservation education other structures, especially Natural Regional Parks, are perceived to be both more competent and appropriate and consequently Parks are seen to have an increasingly important role in conservation education. Basically this is because parks are by their designation committed to conservation and educational objectives dovetail and are directed, however imperfectly, towards the implementation of the World Conservation Strategy in a local regional context. In their educational role Parks seek to explain and interpret ecologocial and ethnographical changes in their environments. Practically - on the ground and within a park's local communities - they also seek to show how a changing environment can be managed, within the context of the careful use of resources, including schools, their staffs and associations, to facilitate the fundamental park strategy of the social and economic revitalisation of their territories.

The practical manifestation of this attitude can be seen in a number of ways, but the overall result has been the development of a co-operative, wide-ranging yet integrative and single-minded approach to the subject. The clear objective is always to relate conservation education to the everyday management of the environment throughout the nation, yet to do it with sufficient sensitivity and flexibility so as to accommodate regional differences and particular circumstances. Significantly these policies and attitudes have developed through the active co-operation between the national ministries of Education and Environment.

At the local level this collaboration works in a number of ways. For instance,environmental professionals (landscape engineers, countryside managers, foresters etc.) and teachers devise educational programmes, with the co-operation of the educational authorities, using familiar local environments to convince students of their value and hence for their conservation-based use and management (Plummer,B., 1984). At the administrative level local agreement have been concluded between the two ministries (Education and Environment) permitting teachers to work as specialist environmental 'interpreters' and as sports instructors within Parks and CPIEs. A further example of this collaborative attitude at the local level is found in the co-operation between the ministries of Education, Environment and Youth, Sports and Leisure. By providing a series of activities not usually associated with conservation education the objective has been to win a wider spectrum of the population, particularly youth, to the cause of environmental conservation. This is achieved by encouraging young people to relax, practice some sport or other pursuit, and then, having harnessed or motivated youthful enthusiasms, to encourage them to go beyond and to discover the environment through their chosen activity at first hand and for themselves (see figure 1).

CONCLUSION

The key to success in conservation education lies in its relevance to the consumer. The French have done much to foster this approach by broadening perspectives and deepening understanding of environmental issues in numerous ways. This has been achieved through a fundamental collaboration between all those who have responsibility for managing and interpreting the environment.

Natural Regional Parks and CPIEs have been welcomed as mainstream participants in conservation education. Co-operative attitudes have also resulted in the formulation of a relevant yet adaptable pedagogical philosophy for conservation education within, and as a part of, the existing framework of social and economic change and development underlining the inseparability of conservation education from the effective management of the environment.

In conclusion, it would be unhelpful to over-emphasise the achievements of conservation education in France, beset as it is with a number of problems, while by implication minimising those in Britain However, it is hoped that these examples of French achievements will inspire a closer look across the channel and a reassessment of attitudes and thinking in Britain.

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ENVIRONMENTAL ACTION IN MALAYSIA : THE EXPERIENCES OF SAHABAT ALAM MALAYSIA; A NON-GOVERNMENTAL ORGANISATION IN ENVIRONMENTAL PROTECTION AND RESOURCE MANAGEMENT

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INTRODUCTION

The end of the Fourth Malaysian Plan in 1985 allows the resource and environmental management strategies of Malaysia to be reviewed by Sahabat Alam Malaysia (SAM) and the experiences of this Non-Governmental Organization in environmental action to be discussed.

SOME ENVIRONMENTAL PROBLEMS IN MALAYSIA

The environmental problems faced by Malaysia today should be viewed in the context of the rapid processes of industrialization and urbanisation. The exploitation of natural resources has largely increased disparities between the rural and urban population, as well as between the rich and poor in urban aras and has eroded the resource base so that future efforts to develop will be jeopardised if immediate steps are not taken to reverse the ecologically destructive trends. Some examples of SAM's fears include:

a) Forestry and National Parks

Even as the Prime Minister himself, in 1981, sounded the warning that Malaysia cuold well run out of quality timber by 1990 if the then rate of logging was maintained, the Penang State Government in 1981 degazetted Bukit Gambier. The hill was allowed to be stripped bare of vegetation and flattened for a luxury housing project. Part of the Kinabalu National Park has been taken for the development of a golf course. In Sabah, the State Government decided to remove the protected status given to the Klias Peninsula National Park in order to allow the setting up of a paper and pulp mill.

Rapid deforestation for commercial timber and extensive cash cropping with negligible investment in conservation and reforestation have led to irreparable damage to the forest base: export earnings for sawn logs and timber for the period 1975 to 1983 amounted to 27,333 million ringgit, while forestry allocation (for replanting of logged-out areas and establishing timber nurseries) under the Second, Third and Fourth Malaysia Plans only totalled 115.43 million ringgit for the period 1971 to 1985.

Apart from losing trees, deforestation raises a gamut of problems. Soil erosion can cause loss of valuable top soil, and heavy slitation of rivers leading to floods. Destruction of catchment areas has resulted in droughts and water shortages. The disturbance of the forest ecosystem is also the forerunner to the extinction of certain species of wildlife.

b) Fisheries

Inshore fishermen, who are also among the poorest communities in the country, have witnessed their livelihood destroyed by overfishing by trawlers which frequently illegally enter coastal waters. Pollution of their fishing ground by wastes washed into the sea by rivers carrying their load from land-ased pollution sources also contribute to reduced fish supplies. The passing of the amendments to the Fisheries Act in 1985 was most welcomed. The new enforcement provisions lay down fines ranging from 50,000 ringgit for local illegal trawling, to one million ringgit for foreign vessels. A maximum imprisonment term of two years and the power to seize fishing vessels and equipment are also included. However, the Exclusive Economic Zone Act 1984 which establishes sovereign rights and national jurisdiction over 200 nautical miles of coastal waters, tends to emphasise resource exploitation rather than conservation management.

c) Food and Agricultural Production

Like many other Third world countries, Malaysia has been trying, since independence, to increase food and agricultural production, and to better the living standards of its agricultural workers.

While great progress has been made in certain areas, food production is not keeping up with population growth and the food bill for 1983 was a staggering three billion ringgit.

An area of grave concern is poverty in the rice-growing areas. As in many examples of agricultural modernisation, short-term profits may be reaped, but new problems or old ones with new dimensions appear. Pests and viral diseases caused by extensive monoculture are but two examples. The use of nitrogen fixing fertilisers, while increasing the quality of padi crops, also speeds up the breeding of pests and spread of diseases. Indiscriminate use of pesticides not only destroys natural enemies of pests but also creates health hazards among human users. At the same time, more and more land is being used for cash-cropping, the construction of highways and housing projects.

d) Pesticides

The use of pesticides in modern agriculture has seen the unprecedented increase in imports over the past ten years: in 1979 Malaysia imported 73,656,800 ringgit worth of pesticides. This increased to 250,000,000 ringgit in 1983. The Pesticides Act 1974 is inadequate and not adequately enforced. Dangerous pesticides continue to flood the market (including those which are sometimes banned in other countries) largely uncontrolled.

e) Other issues

Among other issues taken up by SAM is the question of health and safety in the workplace. Each year about 653 people are killed at work in Peninsular Malaysia and about 63,000 workers suffer injuries in varying degrees of severity.

The dumping of toxic and hazardous wastes in the environment emanates from chemical industries, paint and ink manufacturer, electroplating works and motor vehicle assembly plants. This disposal is conducted largely in secret and the Environmental Quality (Scheduled Wastes) Regulations 1985 is highly inadequate. i.e. mere identification and notification of hazardous wastes would be insufficient control over industries; no standards have been prescribed for the storage, treatment and transportation of the wastes; no criteria have been drawn up for the selection of disposal sites and treatment plants; no provision has been made for inter-agency and inter-ministry coordination and control in relation to hazardous wastes, e.g. Ministry of Trade and Industry, Pesticides Board and the Ministry of Health.

WHAT HAS SAM ACHIEVED SO FAR?

SAM is a grassroots community NGO formed in late 1977 when the environmental movement in Malaysia was still relatively young. From the above discussion it is clear that SAM is involved in a wide range of environmental issues, many of which arise from the problems of rapid industrialisation and the disruption of traditional life styles.

Basic documentation work is carried out on over one hundred related subjects on the environment and development. Research data are put into memoranda to the Government and articles in the press for the knowledge and support of the public. Apart from Suara SAM, the bi-monthly official newsletter, other materials are published. These are for general readers, specific groups such as workers and students (from schools to universities) as well as similar groups in other countries.

COMMUNITY PARTICIPATION

It is perhaps in the field of community participation that SAM places most effort. The fieldwork staff work are actively and closely involved with communities affected by pollution and depleting resources. These include farmers whose crops and lands are destroyed by pests and pollution and estate workers whose health and well-being are affectec by the pesticides which they use without any safeguards. SAM helps these people with the collection of information, drafting of.

petitions, meetings with government authorities, and interviews with the press.

The problems faced by these communities are also publicised in local newspapers (reports, features and editorials) as well as in SAM's own publications and slides. This usually helps to give the affected communities hope and motivation to take positive action in order to solve their own plight. In some cases the situation is improved as the pollution is stopped or compensation paid. However, in most cases the battle is longdrawn and the people continue to keep it up for years with no immediate solution in sight.

EDUCATION

Recognising that education is essential if people's attitudes and awareness of environmental issues are to be nurtured into action, SAM devotes resources into this vital area.

It conducts education programmes and training services for students at all levels - schools, colleges and universities. Workshops are also regularly carried out for youth and women's organisations, residents' associations, workers' groups and trade unions.

Teachers and lecturers are encouraged to incorporate environmental issues into their regular curriculum. In certain cases, entirely new courses have been introduced, e.g. Environmental and Natural Resources Law at the Faculty of Law, University of Malaya.

In early 1985 SAM held a joint seminar with the Curriculum Development Centre to explore the incorporation of environmental studies into a new secondary school curriculum to be implemented in a few years time. An Environmental Handbook published for student research and action may perhaps be SAM's contribution to formal education.

Other educational projects include the formation of environmental clubs, national poster and essay competitions, film festivals, exhibitions and learning through exposure by organising field trips to visit and speak with affected communities.

There is little doubt that the fundamental social anomalies related to the environment can only be tackled by those who have a wide perspective of the problems. A generation made aware of these issues during their formative years could well prove the critical mass leading to positive change.

For the public at large, SAM runs weekly and fornightly columns such as 'Earthwatch' and 'Environment Features' in the national dailies.

In tackling these issues, the objective is to carry out an intensive and on-going campaign to make the public aware of the many environmental problems which beset this country. It is hoped to motivate the need for everyone to involve themselves in changing development policies so that they are in line with sound ecological principles, and with the satisfaction of the basic needs of all in the country this would include the redistribution and proper use of resources, the switch to a lifestyle based on appropriate lifestyles and technology, and policies which will encourage conservation. Change will therefore have to be effected in people's perceptions and values.

INTERNATIONAL LINKS

SAM is in touch with more than 2,000 United Nations agencies, universities and research institutions, trade union secretariats and NGOs all over the world. Information exchange forms the crux of these relationships.

SAM is also a member of a number of international networks : Friends of the Earth International, Pesticides Action Network International (co-founder in May 1982), Nuclear Free Pacific Campaign, Antarctic and Southern Ocean Coalition, Seeds Action Network (formed in March 1985). It is also the coordinator of the Asia - Pacific People's Environment Network (APPEN), which links member organisations in India, Pakistan, Sri Lanka, Indonesia, Bangladesh, Thailand, Malaysia, Singapore, the Philippines, Hong Kong, Japan, Australia, New Zealand and the Pacific Islands. APPEN was formed in October 1983 during a SAM Seminar on Development, Environment and the Natural Resource Crisis in Asia-Pacific. Its main objectives are: the collection and dissemination of information pertaining to development and environmental issues; contributing towards regional collaboration in environmental issues in the region; investigating, reporting and making representations on environmental issues in the region.

CONCLUSION

Malaysia exemplifies many of the environmental problems of developing countries.

A serious and comprehensive approach to development should include the following: conservation of timber, soil and petroleum resources; rehabilitation of fishing grounds and strict enforcement of fishing laws; strict enforcement of anti-pollution laws and the introduction of better legislation to cover more aspects of pollution; strict enforcement of mining regulations; introduction of occupational health and safety standards; improvements of the water, sanitation and other environmental aspects of rural health.

Citizen groups, in this context, have a very important role to play as a public pressure group in articulating public opinion and grievances. Limitations on the effectiveness in opposing certain development plans which are harmful should be taken as a challenge rather than as discouragment forces.

A broad mass education approach is important for NGO activities in order to create awareness amongst different groups in the country. Expertise and skills from all fields of knowledge should be mobilised to defend a common cause with a commitment to meet the challenges of the next decade.

SAM'S PUBLICATIONS ON MAJOR ISSUES OF DEVELOPMENT AND THE ENVIRONMENT

1. The State of the Malaysian Environment 1980/81 (14 pages)
2. State of the Malaysian Environment 1981/82: The Deteriorating Quality of Life (50 pages)
3. State of the Malaysian Environment 1983/84: Towards a Greater Environmental Awareness (96 pages)
4. The State of the Malaysian Environment Dossier 1984 (29 sheets)
5. The Crisis Deepens: A Review of Resource and Environmental Management in Malaysia 1975-1985 (49 pages)
6. Papan Radioactive Waste Dump Controversy (83 pages)
7. Pesticides Problems in a Developing Country - A Case Study of Malaysia (42 pages)
8. Pesticide Dilemma in the Third World - A Case Study of Malaysia (expanded second edition - 79 pages)
9. Environment, Development and Natural Resource Crisis in Asia and the Pacific (422 pages)
10. Environmental Crisis in Asia - Pacific (62 pages)
11. Seeds and Food Security (85 pages)
12. Directory of Environmental NGOs in the Asia-Pacific Region (257 pages)
13. Environmental Handbook - A Research and Action Oriented Guide on Environmental Issues in Malaysia for Students (56 pages)

NEWSLETTERS

1. Suara SAM - Bi-Monthly (16 pages)
2. Environmental News Digest - Bi-Monthly Collection of Environmental and Developmental Issues in Malaysia, Asia and the Rest of the World (70 pages)
3. Asian-Pacific Environment Newsletter (16 pages)

THE ORGANIZATION OF ENVIRONMENTAL STUDIES IN THE UNIVERSITY: A NORTH AMERICAN PERSPECTIVE

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Playwright Noel Coward once said: "Thousands of people have talent. I might as well congratulate you for having eyes in your head. The one and only thing that counts is: Do you have staying power?"

Although one may disagree with the premise of Coward's aphorism on art and the artist as applied in general to the University - that singular modern institution which will tolerate amost anything from a genius, that institution which by its very nature changes as new ideas emerge from the crucible, or shall I say the cauldron, of talented individuals with egos as big as Mount Everest, egos, comingling and often competing to educate people, to advance knowledge and human understanding, and to protect and enhance civilization and the biosphere upon which civilization and all life depend, that institution whose politics, St. Cyr reminded us are so vicious because the stakes are so small - that singular institution which seems to persist in the face of a barrage of odds - to roller-coaster budgets, to conflicting notions of what constitutes sound education and sound organizational arrangements for education - that peculiar institution which manages to sustain itself in spite of the quirks of deans, and chancellors, and provosts, and cantankerous faculty that come and go and come again - nevertheless, Noel Coward's notion of "staying power" as a measure of merit has relevance to the role of environmental studies in the University.

In North America, the field of environmental studies has been around for about a decade and a half or so. Even in North America terms, this is not a long time. When compared to the institutional life of the oldest universities in North America - the Harvards - which had their origin when the new world still seemed so new - fifteen years hardly constitutes "staying power". When compared to the oldest universities in Europe, fifteen years seems but a blink of an eye. Clearly, then, in relative terms environmental studies, as we think of it today, is a new field, and as the old adage says, "You can't make a good pickle overnight, just by squirting a little vinegar on a cucumber. It takes a while." Still, after fifteen years, if the cucumber has not been transformed into a pickle, you might as well start canning tomatoes instead.

Although to some disciplinarians there seems more similarity between environmental studies and picklemaking than between environmental studies and higher education, not a few of even the most adamant naysayers, have had to tip their hats to a field that has significantly transformed many universities, and has made noticeable contributions to human understanding and human welfare.

In recent years, after the first faltering starts in North America to differentiate environmental studies in the university from extopia freakdom, from the hug-a-tree-kiss-a-flower sentimentalists, from the radical preservationists and march-in-the-streets ideologues, as well as from that part of the scholarly community who steadfastly maintained that the environment was their turf - the geographers, earth scientists and ecologists - environmental studies has more and more come to be recognised as a quasi respectable field. Given the fact that no wise betting man would have put his money on a field that generated so much opposition and which made so many mistakes early on, perhaps fifteen years does represent real staying power. Still it is no news to this audience that doubts about the rigor of environmental studies persist as does the condescension toward those who continue to take the field seriously and make environmental studies their life work. And even where environmental studies is tolerated or even embraced there is a seemingly never-ending debate as to how the university should treat environmental studies.

Since 1966, a raft of commentators including Caldwell (1966; 1983), Steinhart and Cherniak (1969), Hare (1970), Schoenfeld (1971; 1979); Bryson (1976), Odum (1977), Wolman (1977), Davis (1978), Sacks (1978), Cairns (1890). Perrine (1982), Harde (1984), and Borden (1985) among others, have written about the nature of environmental studies and environmental science, and ways the university can respond intellectually and organizationally to the interdisciplinary study of the human-environment system. In this talk, I wish to discuss briefly the nature of such study, review the underlying conflict that has been evident within the university community in North America since environmental studies came onto the scene, and argue for a minimum set of organizational requirements essential to achieve excellence in environmental studies in the university.

THE NATURE OF ENVIRONMENTAL STUDIES

In order to understand the difficulties that have arisen in placing environmental studies within the university, it is first important to recognize how the field began and what it attempts to do. Though environmental studies had antecedents in the disciplines, it is readily apparent that the field emerged rapidly during the 1960's and 1970's as a result of what Caldwell (1984, p. 249) refers to as "an ad hoc response to the sudden emergence of public concern". This concern, was perhaps first articulated as the perception of pollution as a direct threat to human wealth and as an indirect threat to human welfare through undermining the natural resources - air, soil and water - upon which society depends for its well being. Two points are important here: (1) that this academic field was spurred by public concern; and, (2) that this concern related to problems of a "real worlds" nature that demanded action by public and private sector decisionmakers. As environmental studies matured, the scope of the environmental "problematique" shifted from our own backyards to the biosphere as a whole, and broadened to encompass a more sophisiticated understanding of the inextricable interconnections among population, resource availability and resource consumption, the noxious and troublesome byproducts of consumption, the positives and negatives of technology, and the web of institutions and beliefs called society or culture. Throughout this maturation process, however, the inherently interdisciplinary and problem oriented nature of issues requiring societal action have continued to be the lynchpin of the new field.

Regardless of the specific issue under investigation - environmental or otherwise - as Wolman (1977) has observed, "The rationale for interdisciplinary studies is based on the common observation that problems in the real world are not separable into disciplines." The failures of the disciplines unilaterally to address such problems with success are well known to us all in natural resources and environmental studies. One classic example of such an effort - a World Health Organization attempt to eliminate anopheles mosquitos in Borneo - related by Cornell University's Dr. Lamont C. Cole and retold by Cairns (1980, p. 31), however, will drive home the point:

"DDT was sprayed to kill mosquitos, and it did. However, it did not kill roaches, which got along quite well with concentrated doses of DDT in their bodies.

Long-tailed lizards, preyed on the roaches, got DDT in sufficient amounts to affect their nervous systems. The lizards became less agile and were eaten in quantity by cats.

The still more concentrated DDT from the lizards began killing off the cats. With the number of cats diminished rats started moving in from the forests, bringing a threat of plague.

The technological solution to the problem was to parachute cats into the village to catch the rats, which was done.

But then the roofs of houses began falling in. The lizards, it turned out, had also been eating caterpillars. The caterpillars feasted upon the thatching of the native roofs."

"The moral of this story, "Cairns goes on to say, "is that while a competent professional in a particular discipline can usually say what a technology is supposed to do, it usually takes people in a variety of other disciplines to say what else it will do." In other words, we should not forget the old song lyric: the knee bone is connected to the thigh bone. Or, to put it another way, quoting H. L. Mencken, "For every problem there is solution, simple, neat and wrong." The interdisciplinary environmental approach does not take a principled stand to eschew simplicity, but if the field had a motto, it would be, "It's more complicated than that!"

The problem focused, applied and action oriented nature of interdisciplinary studies in which lies its strength and its raison d'etre, ironically have made its placement in the university problematical.

As Hare (1970) points out, traditional disciplines are "largely analytical," not synthetic in their objectives or in their methods" .... On every campus," Hare contends, "there is a deadweight of opinion that regards action-oriented programs as hostile to the academic life."

Although problem solving efforts have been major aspects of professional fields such as agriculture, business, engineering, law and medicine (Steinhart and Cherniak, 1969; Wolman, 1978; Caldwell, 1984), in the main, these have been oriented around disciplines. Here I intend merely to be descriptive, not evaluative. If such efforts at times have involved multi or cross-disciplinary cooperation, until recently, they have rarely employed an interdisciplinary approach in the sense of creating a new synthesis of knowledge and experience that integrates the broad fields of the social sciences in an attempt to respond to situations that require reaction to a current crisis, the design of a plan to avoid a prospective crisis, or the anticipation of a future problem. Each of these situations demand a public policy response - control measures, strategies for future action, whatever.

Steinhart and Cherniak as well as Hare correctly distinguish between the disciplinarian who makes a choice to explore a problem that is compatible with his or her own competencies and interests, and the problem focused researcher who investigates inherently interdisciplinary, real world problems that are "out there" and must be reckoned with, problems for which there is no neat disciplinary competency. The disciplinarian normally selects problems within the general framework of a discipline and rejects those that lie outside. The interdisciplinary environmental studies investigator, on the other hand, more often responds to a set of actual conditions that necessarily exceed whatever disciplinary competence he or she possesses.

Education and training, even within professional fields such as agriculture, law, engineering, and medicine traditionally have been structured along disciplinary lines, have been compartmentalized around a "core body of knowledge" with clearly defined, if sometimes controversial and debatable paradigms that structure the field. By their nature, however, environmental studies attempts to deal with complex social problems, and, to reiterate, no such problem lies within the competence of a single academic discipline and requires a synthesis of competencies or new competencies to address.

That modern science has advanced human knowledge with incredible speed and definition cannot be disputed, nor can the dependence of environmental studies on the disciplines. In large measure, the tremendous advances of the basic sciences have been achieved through the analytical approach of the disciplines that separates a complex phenomenon into its most element parts (Caldwell, 1984). As Caldwell has argued, the more "fully developed and reliable" basic sciences have advanced through an ever more progressive degree of reductionism.

But, Caldwell does on to say, even if "there is no substitute for breaking down the constituent elements of phenomena into their parts and investigating how these parts relate in forming the whole ...," nevertheless, "... the necessity and practical successes of reductionist science have caused some persons to equate reductionist methods with science per se."

The result of this great leap has been the confusion - perhaps prejudice is a better word - that reductionsist science is the only science worth a scientist's creative energy and effort, and that fields which rely heavily upon methods of synthesis - environmental studies, for example - are suspect, if not downright inferior endeavours developed by those ill-equipped for the real work of sicence. Such fields are seen as "soft" sciences if not as "non-sciences." A linguistic psychologist could have a field day examining the terminology applied to such matters, exploring the psycho sexual and cultural implications of the terms "hard" and "soft" sciences. Whether sciences are "erect" or "flaccid" is hardly the issue, however. Nor again, is there any doubt that strong disciplinary perspectives are the essential grounding for understanding aspects of complex environmental systems and provide critical information necessary for environmental problem resolution. But the disciplines themselves - isolated as they are within the university and isolated as well by language and other communication barriers in the world at large - are insufficient. What is at stake in the prsent context is the status within the university of fields which aspire to establish, in Caldwell's (1984) term, a "metadiscipline," a mode of inquiry that transcends multi or even interdisciplinary understanding to achieve a coherent body of theory which explains environmental relationships. It is the status of such efforts, how they are treated within the university, and what structures within a university are best suited to respond to them that I turn to next.

UNSCRAMBLING AN EGG : THE UNIVERSITY AND ENVIRONMENTAL STUDIES

The problem of the undisciplinary compartmentalization and the increasingly specialized narrowing of knowledge which is so much a part of being a limited human caught in the modern world of limitless information, has affected the university in the same way it has affected other social institutions and the organization of human effort. Coupled with the knowledge problem, however, is the problem of limited financial resources which perforce has created pockets of vested interest in the university who give further impetus to the wall building and territoriality that transforms disciplines into administrative units: departments, schools and colleges.

With his usual double edge, American poet Robert Frost in "Mending Wall," wrote, "Good fences make good neighbours." When there are walls, when the boundaries are clear, there are definitive conceptual, legal, moral, and social conventions to follow, and such ordering of the chaos around and within us makes life easier. It is no different in the university, though the advancement of knowledge and the resolution of environmental problems are often better served by wall leaping and crack widening than wall mending.

It is too easily forgotten, however, that universities have an organic quality of their own, that their parts change, grow, or are sloughed off as the conceptualizations of knowledge and the world are altered by new discoveries of emerging needs and opportunities. Some in the university, forget, for example, that biochemistry, anthropology, and geography have not always been discrete disciplinary units, and that the notions of departments and fields vary with the special histories and arrangements in different institutions. In reality, the wall are moveable, though increasingly there are more and more of them to move.

Disciplinary departmental walls are only one aspect of the divided house that is the modern university. Another division is the intellectual clanism, described by Hare (1970, p. 352). Because of the venue of this Conference, it seems especially appropriate to quote it here:

> "We also bang ourselves against a clan spirit of the traditional faculty groupings. Humanists, social scientists, and professionals like lawyers and engineers may fight like cats within the clan, but they close ranks and hitch up their kilts when someone questions their loyalties. Environmental studies have to involve many of the clans, which are not used to combining in the way required. If we suggest as I do, that some of them - notably the humanists - may be utterly transformed by such combinations, we alarm the timid and anger the Tories among them."

Through these many processes designed for intellectual, psychological, financial and institutional self-protection, the university and its curricula have become a scrambled egg of sorts, still a whole, perhaps more palatable and eatable, but far more amorphous than its uncracked progenitor. Although universities are supposed to provide a smorgasbord of offerings, fulfilling the diverse appetites of inquiring minds, in terms of devising a structure for digesting environmental problems there is considerable virtue in unscrambling the egg. And we all know how to unscramble an egg: you feed it to a chicken.

There have been many different kinds of "chickens" to restructure the university so that it can treat environmental problems and issues wholistically. All too often, however, these have laid eggs in the colloquial sense. As the first popular enthusiasm for environmental studies captured students imaginations and credit hours, many existing departments set the table and prepared a menu of courses and programs. This is not to suggest cynically that reputable departments in universities and colleges across North America were motivated by avarice, though at times the entrepreneureal spirit may have been a key motivating factor. Recognising a pressing student demand, however, and recognising that amid the furor and ferocity of students riots over the Vietnam war, here at last was a socially constructive, ecologically sound effort that, coincidently, could channel energies away from hurling bottles to picking them up, higher education sought to respond.

Schoenfeld (1979) and others have documented the remarkable phenomenon of departments and courses being renamed to reflect the new concern, of new courses, research centers and institutes, new academic departments, and in some instances, new schools and colleges springing up almost overnight. Efforts were made to bring teams of researchers together to tackle problems for which there were ready funds. All too often only a multi-disciplinary snapshot of the problem was achieved, and not the synthesis the problem demanded or the researchers desired. Many such efforts quickly faltered, collapsing after the first rush of enthusiasm. In some instances, this was due to a conceptual failure as to what constitutes interdisciplinary environmental studies. In other cases, there were insufficient faculty personnel to create the "critical mass" required to build an effective program, or inadequate institutional financial resources to support it. Elsewhere, there was substantial resistance from segments of the faculty or the administration or both who were unwilling to commit available resources to a "fad" that appeared to promote education, that sacrificed depth for generalism, which lacked rigor and which threatened to compete with and undermine traditional departments and programs.

Programs at other institutions declined more slowly as state and federal administrations changed and funding priorities shifted from environmental concerns toward high-tech or defense related fields. Students and society as a whole turned away from the boom of social conscience to the bust of an economy weakened by the energy crisis, fighting an unending deficit, severe unemployment, and the fear that that the standard of living we have grown accustomed to in the West was threatened by regulation that promised virtues for an unspecified better future at the expense of present needs and comforts. This story has been detailed in the popular press and elsewhere, and I will not dwell further on it here.

If many environmental programs succumbed to a plethora of factors, others survived and flourished. Some key factors for their success can be identified. At the heart of such success I would argue has been institutional arrangements to insure essential interdisciplinarity, academic quality, and programatic flexibility.

BUILDING A BETTER CHICKEN

Environmental studies have been institutionalized in the university in an almost infinite variety of ways. In some institutions environmental studies means multidisciplinary or integrated interdisciplinary research housed in a research center or institute. In others, it means an instructional effort at the undergraduate or graduate levels or both, organized as courses, majors or degrees offered by existing departments or operated through an interdisciplinary departments or housed in a discrete entity with its own faculty with or without joint appointments with disciplinary departments. At still others institutions, the program involves both a significant research component housed in a center or centers, and an instructional component at undergraduate, graduate, or postdoctoral levels, or any combination of these. Often, the research or instructional elements may have a specific subject focus: water, energy, land, whatever. As Caldwell (1984) has noted, such program specificity now seems to be changing, as environmental studies takes on its own agendas rather than responding merely to current public issues, exploring problems at global and biospheric scales rather than merely local or regional ones.

At the undergraduate level, the instructional environmental studies curricula may function as a separate major which may or may not be tied inextricably to a disciplinary major. Undergraduate efforts vary from focused pre-professional training to an expansion of a liberal arts degree. At the graduate level, degree programs may center on either masters or doctoral programs or both, and may have either an exclusively professional environmental management focus or a research focus with professional management components.

Though the nature and quality of programs necessarily vary with specific institutions - their histories, the talents and interests of their faculty, and the level of funding support available - the stability and longevity of an effort depend heavily upon some key elements. The history of environmental studies in North America reveals that the following organizational elements are required for success:

(1) regardless of the program focus, successful programs require sufficient, active faculty participation from the full spectrum of the broad fields of knowledge: the physical and biological sciences, the social sciences, the humanities, and, where possible, participation from professional schools: agriculture, law, engineering, business, and medicine;

(2) whether faculty participants have appointments solely in the disciplines, solely in interdisciplinary environmental studies, or hold joint appointments, they must have a real stake in the program. This means both

    (a) that they must be able to organize and control the interdisciplinary curriculum and research efforts, following their professional and intellectual interests seizing new ideas and opportunities as they arise, and

    (b) that they participate in the hiring, promotions, and salary levels of those engaged in the effort. Optimally, as in the case of John Hopkins University

(Wolman, 1977) or the University of Wisconsin-Madison, the program should have a core of interdisciplinary faculty - 10 to 15 individuals are best to provide the needed "critical mass" - whose careers and professional development are determined primarily by their participation within environmental studies and not within disciplinary departments. The environmental studies unit, in other words, ideally should have a core of faculty tenured within that unit. Although it is important for these individuals to maintain ties with disciplinary departments to insure their own connection to developments within the disciplines and enhance disciplinary departmental involvement and understanding of the environmental studies effort, their home case should be in environmental studies.

To be truly successful, the reward structure of the university must accommodate the faculty's interdisciplinary efforts. Without this, faculty particularly at the junior level, are subject to two or more divergent sets of requirements for promotional and salary purposes. In most traditional universities, this necessarily demands pleasing the disciplinary faculty to whom they are accountable: publishing in disciplinary journals, conducting disciplinary research etc. It also means that during tight financial times or periods of unusual departmental activity, the disciplinary home has first call on faculty time. Faculty from academic units outside of environmental studies, however, should be encouraged to participate within the program, to lend their expertise, talent, and advice. These individuals may be salaried on a continuing or ad hoc basis for specific tasks. Every effort should be made to involve the broadest participation from campus faculty.

(3) In order to accomplish (2), the enviornmental studies units should function as a free-standing academic unit with its own budget, serving the full campus community by reporting not to a dean within one college or another, but to the chief academic officer of the campus or his/her designee. By definition, environmental studies involves faculty with varied disciplines, cutting across departmental and school or college lines. The unit, therefore, should not be subject to budgetary and other pressures of competition among departments in a college. Such a free-standing unit, however, must be permitted flexibility to involve faculty from outside its immediate boundaries, and mechanisms must be established which reward departments and schools for lending their support.

Many mechanisms have been or could be devised to accomplish this. For example, credit hours generated by a disciplinary faculty member through the interdisciplinary unit can be awarded to the home department of the faculty member, and the home department can be permitted to keep salary savings if one of its members is "picked-up" for a time by the interdisciplinary program. In some instances, departments could be provided with extra permanent faculty personnel because of its willingness to share in the work of environmental studies. The point here is that efforts need to be made so that the home department does not perceive itself to be penalized if one of its faculty participates, and interdisciplinary environmental studies should not be framed in such a way so as to fix its own walls, discouraging free and open participation from as wide a group of faculty as possible.

Still, the environmental studies unit should be given a permanent place in the university structure. If it is considered experimental in nature, if it does not have the full rights of other academic units with faculty, degree, budgetary, and student affairs responsibilities, it will be perceived as a temporary phenomenon, more vulnerable to the vagaries of extramural funding, and more dependent upon the interests and power of a few key individuals.

The story of environmental studies in North America has been the story of interdisciplinary studies in general, of prestigious senior faculty members with sufficient imagination and stature to create a program and to withstand personally the opposition from traditional departments. When these individuals, through attrition, are no longer present, such programs have atrophied or been eliminated. An institutional structure, therefore, must be in place to overcome the many forces that exist within universities that serve to maintain the status quo, i.e., traditional disciplines. With such a structure an interdisciplinary program can continue beyond the lives of its originators. The structure itself represents the university's long standing commitment to such effort and helps guarantee stability over time.

There is little doubt that North American universities have been changed significantly by environmental studies over the past 15 years. In one form or another environmental studies is represented at every major university and liberal arts college. Although program success has varied widely, and although many of the programs developed early on are no longer in place, the university has adapted to change, and it is unlikely that environmental studies will be eliminated from the scene regardless of the exigencies of budget and politics. Once embraced, the idea of environmental studies cannot be erased: the issues of booming population worldwide, of resource depletion and competition, of political instability in a world of nuclear infernos and nuclear winters - issues that threaten the very life support systems of the planet increasingly will not allow us - individually or institutionally - to run from them. Our experience with organizational arrangements within the University has pointed the way to secure and strengthen a field which we as educators, as the privileged, cannot afford to let languish.

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EXPERIENCES AND TRENDS IN ENVIRONMENTAL EDUCATION AT UNIVERSITY LEVEL IN THE NORDIC COUNTRIES

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INTRODUCTION

Let me start by briefly explaining why I think that our experiences of environmental education in the Nordic countries might be relevant and why one should take warning from some of the trends that we can see now. The Nordic countries - Denmark, Finland, Iceland, Norway and Sweden - are small countries; the total population is around 20 million people. The experiences that we collect in the relatively small university systems may in some ways be more relevant to the situation in the United Kingdom, particularly that of the polytechnics, than those that come out of the United States. In the U.S. the surviving environmental education programmes tend to be on a much larger scale incorporating a multitude of courses, fragments from various disciplines, several institutes etc. Environmental education at university level started relatively early in the Nordic countries. Some programmes were well underway in the late 60's. Thus there is a substantial amount of experience collected and some of it has been subjected to systematic analysis. Finally, it is my personal opinion that we can see a number of worrying trends in the development of environmental education, particularly the interaction between environmental policy and environmental education, that educators in other countries should look at carefully and take warning from.

One of the worrying trends that I perceive is the tendency for environmental education to be squeezed out of university programmes without careful analysis of the needs of students. Education should ideally respond to a view of reality, and one of the worrying trends is that it seems that this view is acquired more through newspapers than through careful analysis of environmental problems that we are facing. Before you jump to conclusions let me say I am not talking about the establishment of environmental programmes, but about the trend in universities to abandon environmental education. The present political climate and level of debate on environmental matters simply suits a large group of academic reactionaries, who, under banners of 'back to fundamental knowledge', 'quality' etc are promoting their own specialities. Perhaps this would not be much to comment on if it were not for two things: the first is that the reactionaries can indeed point to a sufficent number of ill-conceived environmental education programmes and courses, in particular in so called interdisciplinary programmes. In Scandinavia this has taken a special form that I shall come back to i.e. the many programmes established by small regional colleges.

The second problem is that the superficial analysis of our environmental situation, which seems to be behind the trends, is not only wrong, but counterproductive and downright dangerous in the long run. It is therefore my intention to start off by making a number of points concerning the changes in the environmental problems that have occured during the last decade.

THE CHANGING ENVIRONMENTAL SCENE

The clean-up phase of environmental policy is, at least in the theoretical sense, over or nearing completion in the Nordic countries. Simple measures, such as building municipal sewage treatment plants, installing air and water pollution control devices at the larger industrial point sources, have been taken.

Generally speaking there is adequate legislation to control most environmental problems. It might be argued that there are exceptions to this. Possibly the most noticeable possibility being the control of hazardous substances, but in general it is probably more a question of monitoring the control than availability of relevant legislation that is the problem.

Public support for environmental measures, even fairly stiff ones, is reassuringly high in spite of economic problems and a changing political climate.

The public debate on environmental problems - especially that proportion which is dominated by leading politicians, industrialists and bureaucrats - is unfortunately in my opinion full of erroneous conclusions. The most important of such conclusions that seems to be circulating is that the environmental problems in the Nordic countries have largely been solved. This is hardly true. The environmental problems have changed and are now of a nature which makes it possible for the superficial observer to think that they have been solved.

The problems are less visible. It is no longer stinking rivers with dead fishes floating upside down or dark clouds of smoke stacks that are the problems. The problems are of a much more invisible kind, such as the slow build-up of a number of heavy metals both in nature and in human organs, the increasing acidity of lakes, rivers and forest soils. Such slow and invisible processes are much more difficult for the media to cover adequately and lack of attention can easily be mistaken for a lack of problems.

The environmental problems that we now face are also more diffuse. It is not point sources but such problems as emissions from cars that worry us. Whereas point sources are reasonably easy to control the diffuse pollution caused by many small sources is much more difficult to combat. The problems are also more complex and interacting - the obvious example being the interdependence of heavy metal pollution and increasing acidity.

The view that environmental problems can be solved with simple pollution control devices which has been underlined by the success of municipal sewage treatment programmes and pollution control at large industries, is hardly relevant to our new situation. In fact it might be argued that it never really was relevant. Although municipal sewage treatment has reduced the releases of organic matter into fresh water in Finland and Sweden and into the Baltic a much larger reduction has occured because of the restructuring of Finnish and Swedish pulp and paper industry, something that has nothing to do whatsoever with environmental policy.

It seems also that there is a widely held belief that environmental policy is expensive and unproductive. Pollution control may naturally be costly to an individual industry but this obviously leaves aside the problem of externalities. The pollution control pogrammes so far carried out have not been expensive from the point of view of social-economics. Studies made for instance by the OECD have shown that environmental policy in the industrialised nations has created more jobs than it has taken away and that the effects on inflation have been insignificant.

To sum up it seems that the lessons that one can draw from the development of the last decade and a half have not really been learnt. At least they do not appear to influence the public debate or attitudes of educational planners or traditional academics. The fact that more important results would result from technological development and restructuring and modernisation of industry than from conventional pollution control should have large implications for university education. But, as I say, it seems that this has gone unnoticed. It certainly has had very little influence on the thinking of those who plan the education of engineers in the Nordic countries.

The problems are aggravated by the fact that there is in fact very little tradition of planning education after analysis of needs for knowledge in society. With centralised systems of higher education the effects of bad planning will be relatively worse than in more diverse, decentralised systems. The tendency to focus more on indicators of labour market demand in the last two decades will also aggravate the lack of foresight and planning in the systems. Educational systems have large inertia - the lead time between planning a change in education and this having an effect whatsoever on society is in the order of many years or decades. Using the labour market as an indicator of real need for knowledge tends to be what I call 'retrospective futurology'. A further problem is that students are influenced by labour market considerations, which are often of a superficial nature. It is natural that they will react to trends and fads which are strongly reinforced by media.

TYPES OF ENVIRONMENTAL EDUCATION

Now with this as a background let me turn to an examination of the development of environmental education at university level in the Nordic countries.

First of all we need some kind of systematics with which to analyse the situation. We have found it useful to recognise four different needs for education and educational strategies with regard to environmental problems.

1. There is a need for the integration of environmental problems and matters into a number of different courses and disciplines.

2. There is a clear need for interdisciplinary, short overview courses which will give awareness rather than actual competence or training.

3. There is an obvious need for specialists training in both old fields and disciplines of environmental policy and in emerging ones.

4. There is an urgent need for complementing the education of professionals, both those already in the market place, and those coming out of our institutions with much more thorough environmental education.

INTEGRATION

Integration is obviously the most difficult to assess. It seems, however, that there is relatively little reason for complacency. Let us look first at the positive signs. In higher education in the agriculture and forestry sectors all the institutions in the Nordic countries have some sort of environmental centres, which seem to run not only their own programmes for a minority of students but also have some real impact on the general education given by the institutions. This is probably because the environmetal problems have become of more immediate legitimate concern in the eyes of these groups with increasing scientific acceptance of the reality of environmental problems within agriculture and forestry. The obvious examples are pesticide effects, ground water pollution by nitrogen compounds and in Scandinavia, most important of all, the effects of increasing acidity of the precipitation.

Some faculties of law have introduced chairs of environmental law recognising this as a legitimate subject in its own right. It is interesting to note that these chairs have largely been introduced through outside pressure and that they seem to have a significant proportion of their teaching load outside the faculties of law.

Teacher training and in-service education has in many cases integrated environmental matters into both social science and natural science programmes.

The most notable negative factors are:

The failure of higher education aimed at administration, economics etc. to integrate, or indeed in most cases to take any notice whatsoever of environmental problems. This is obviously dangerous from many points. An increasing number of students seem to be choosing this kind of education. The present political climate fosters an entirely unfounded belief in the power of economics to arbitrate in important value conflicts over environmental matters. A narrow business economic training coupled with attitudes to environmental problems acquired from the public debate rather than from any serious academic analysis will obviously be counterproductive.

The most important negative factor, however, with regards to integration that I want to spend some time on is the failure of the institutions of higher technological training to take the environmental challenge seriously.

At present we are conducting an indepth study of the Norwegian Institute of Technology to assess the exact degree to which integration has been carried out. The preliminary results are not encouraging. Particularly if you view them in conjunction with a drop in student attendance in interdisciplinary, environmental courses.

Most clearly you can see the problems of integration if you compare the development of education on the physical, outer environment or the ecological aspects of environmental problems with the education at the institutions of higher technological education on work environment problems.

A number of points emerge from such a comparison:-

i) The work environment is seen as a legitimate concern by a large segment of engineers and an unavoidable one by most of the rest. With the cost of labour being the main cost factor in many industries (and perceived to be so by politicians and in the general debate for almost the entire industry) work environment becomes a technical and economic factor to be taken into design and planning. It pays to keep labour turn-over down and to compete for skilled labour with a good work environment.

ii) If one now compares this with protecting the physical environment which is seen as a restriction on industrial activity and hardly as a legitimate primary concern of engineers. Environment protection is imposed and standards grudgingly met. As I pointed out environment protection is seen by many as a luxury that the present economic situation provides an excuse to get rid of.

iii) An important difference is also that the work environment has become institutionalised within the centres of higher technical education.

The problems of multidisciplinary introductory or overview courses are mainly that the first boom is over. Such courses exist in most universities and other institutions of higher education. The tendency is, however, dropping and it seems clear that this drop is selective. Those students who go into the lines of study leading to the best paid jobs are those who have dropped out of such programmes. It is also quite clear that such interdisciplinary courses are having a hard time in the specialised institutions - business schools, institutes of technology etc.

OVERVIEW COURSES

The need for overview courses is quite clear although they are now held in low esteem by the academics. The Swedish energy debate a few years ago, in particular the intense public debate before the nuclear referendum, is a case in point. It is quite clear that even the most elementary, interdisciplinary overview of the problems of energy and environment would have been useful to the many so called experts, not least senior academic experts, who took park in the debate. It has been pointed out that the interdisciplinary overview courses only give awareness but not necessarily competence in the field. However, awareness of the existence of some problems and a number of elementary facts would have been useful in the debate; such facts that make a professor of physics or biology understand that he is not an expert on energy systems or an engineer to understand that the correlation between energy and economic development is not simple. A little interdisciplinary education would not have made them competent but it might at least have made them somewhat more humble.

SPECIALIST EDUCATION

Specialist training is a field that I am not going to examine in depth. In a sense it is no real problem. This is the area where signals from the labour market will be reasonably easy to interpret for the institutions of higher education. A good example from the Nordic countries is the upgrading of the municipal health inspectors position in Finland and Sweden. The university system has reacted by producing solid and well conceived programs for this group of specialists and they have a reasonable level of academic quality. A number of engineers specialising in sewage treatment, noise reduction, air pollution control etc. are also produced, and in a survey of bottle-necks in economic development, as perceived by Norwegian industry, the lack of knowledge in these fields was never mentioned. (It is of course a totally different question whether these specialists have received a training that makes them able to see their speciality in a perspective).

A more important development seems in this area is the creation of programmes that produce what one might call pseudo-specialists. In the 1970's a number of new regional institutions of higher education were created in Norway and Sweden. In many cases these grew out of colleges of teacher education. In these institutions the ambition to deal with problems relevant to social needs is usually much greater than in the universities. In many of these institutions, programmes which in theory look quite good were created. The problem is, of course, that small institutions have very limited capacity and programmes have become very dependent on a few individuals. Heavy teaching loads or the fact that these enthusiasts move on makes it difficult for the small programs to develop with the times and changing of nature environmental problems. So we are faced with the paradoxical situation that those who theoretically should be able to create good interdisciplinary environmental programs do not want to and those that want to, have a doubtful competence to do so.

COMPLEMENTING A SPECIALIST TRAINING

The problems of complementary education have been acute in all the Nordic countries. In the early 70's ambitious programmes of half to one academic years duration were created. The interdisciplinary approach was real and these programmes attracted good students and had access to good staff. Usually these programmes were not set up as separate institutions or courses but relied heavily on other institutions. It was therefore possible to draw on the entire expertise of the large universities. Staff could be changed as new problems appeared and needed competent treatment. Today only one of these programmes that I am aware of in any Nordic countries is still in operation. The number and quality of students dropped. University bureaucrices reacting to the public debate lost interest and funding dropped. Staff members moved on to more rewarding areas. Today we can say that the complex and interacting nature of environmental problems has increased the need for taking various specialists and giving them a thorough environmental education. But this is simply not occuring. It seems that where the intermediate academic level (approximately the Masters level) exists, most Nordic university systems regard that as an appropriate place for further specialization rather than for broadening out. So whereas the development in the United Kingdom from an initial boom has dropped to a level that may be suboptimal, but not desperately bad, the situation in the Nordic countries can be regarded as serious in the long run. In particular, it seems to me that engineers, biologists and, perhaps to a somewhat lesser degree, social scientists and geographers are not getting the training that they should be getting.

NORDIC CO-OPERATION

For the past decade there has been active Nordic co-operation on environmental education at university level. In recent years a Contact Group for Enviornmental Education has organised seminars on environmental education in various university disciplines. The group has produced a series of text-books covering a wide range of topics and has acted in a catalytic and co-ordinating role for environmental education in the Nordic countries.

Nordic co-operation is extensive and covers most aspects of social, economic, technical, scientific and cultural policy and development. In the area of education and culture formal co-operation between the Nordic governments started in the late 1940's. Since 1972 a Nordic Secretariat for Cultural Co-operation located in Copenhagen has been the focus of this work. The environmental education contact group is active within the frame-work of the secretariat.

In the field of environmental education co-operation is natural for many reasons. On the one hand the natural characteristics common to the Nordic countries means that the environmental problems of all countries are to some extent similar. On the other hand each country has sets of special environmental problems due to differences in natural conditions or social, economic or technical development. Comparisons become fruitful since these differences occur within a wider framework of common characteristics. Nordic co-operation in environment protection is a further reason to co-operate also in education. A Nordic convention on the protection of the environment is a concrete result of this co-operation.

In 1972, the Nordic Council of Ministers decided on an action plan for environmental education.

For the university level several areas for co-operation were identified:

(a) Production of teaching materials.
(b) An annual, specialised seminar on environmental education.
(c) Nordic co-operation concerning environmental education related to the Nordic efforts at international development work.
(d) Co-ordination of the environmental components of the research and education of other Nordic institutions.
(e) Regular updating of the inventory of courses in environmental education of other Nordic institutions.
(f) Regular updating of the inventory of courses and literature at university level.
(g) Expert evaluation of courses and curricula on a Nordic exchange basis.

In order to carry out the concrete work a Contact Group for Environmental Education at University Level was appointed by the Senior Officials' Committee for Education and Cultural Affairs. The group has initiated several projects:

Series of Seminars on the Integration of Environmental Matters in Higher Education

The object of holding a series of such seminars is to promote exchange of information and experience. Participants and lecturers at these seminars come both from education and from environment protection, industry, national administration etc. Discussion and planning of the production of textbooks and other educational material is an important part of these seminars.

- technological education
- agricultural education
- planning
- biology at university level
- geology, geotechnics and physical geography
- integration of environmental aspects in the teaching of Law.

Production of Educational Materials and Textbooks

As a result of preparations, discussions and deliberations at the various seminars a number of textbooks have been produced.

The contact group has throughout its work stressed the importance of using the joint Nordic experiences in international development work to promote the integration of environmental education into the training of development personnel. In co-operation with the develop-agencies of the Nordic countries text specially aimed at development personnel or environmental educators concerned with international development are being produced. In order to make them more useful for the purpose forthcoming texts will be produced in English. They can thus be used also in international seminars organised by the various development agencies.

TOWARDS INTEGRATION: SOME STRUCTURAL AND ORGANISATIONAL MECHANISMS

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INTRODUCTION

A major goal of environmental programmes in Higher Education is to prepare students with conceptual understanding, technical knowledge and general awareness needed to understand the complex environmental problems of modern society. It is generally felt that this goal involves a wide range of disciplinary cultures, philosophical perspectives and even ideological stances.

To translate this theoretical general goal into practical outcomes and forms involves several levels and dimensions of integration. The problems of devising and implementing strategies and tactics of integration continue to bedevil the minds of practitioners and progress has been painfully slow.

This paper is concerned with the notion of integration especially in relation to those environmental courses which purport to be 'overview' or 'holistic'. It examines different theoretical styles and states of integration and then explores three separate but overlapping practical dimensions of the notion relating to

1. academic content;
2. instructional procedures; and
3. organisation.

It draws upon experiences gained at Sunderland over the last ten years and in particular in the innovations currently being implemented in its environmental degree course. Whilst some features of this experience are unique, it is hoped that others may bear generalisation to other cases and countries, thus generating discussion and opinion.

THE IDEA OF INTEGRATION

Integration is defined as the 'making-up a whole by adding together the separate parts or elements' (OED). In the context of education it is variously interpreted according to particular assumptions about the function of knowledge and learning, the organisation of institutions and the needs of students and society. Most commonly, it is made most explicit in relation to subject matter, referring to the process of co-ordinating different disciplines in the study of topics.

The ultimate aim of the integration of subject material is presumably the disappearance of disciplines as organising constructs through which and by which knowledge and understanding are gained. The OECD-CERI (1973) report provides the terminological basis of the discussion on integration:

Discipline	a specific body of teachable knowledge with its own background of concepts, procedures and methods.
Multi-disciplinary	the juxtaposition of various disciplines, sometimes with no apparent connection between them.
Pluri-disciplinary	the juxtaposition of disciplines assumed to be more or less related.
Interdisciplinary	an adjective describing the interaction between two or more different disciplines. This interaction may range from simple communication of ideas to the mutual integration over a wide field.
Transdisciplinary	a state when a common set of axions prevail, lying beyond on outwith traditional disciplinary cultures.

Transdisciplinarity is considered the most 'rarified' form and, presumably, the theoretical end product of 'total' integration. Between transdisciplinary and unidisciplinary endeavours there are obviously many intervening combinations (Figure 1); although not always do they need to occur sequentially.

It is never clear whether integrated environmental courses seek to attain transdisciplinarity as the ultimate ideal expression of their educational objectives. There are many reasons why this state is very difficult to achieve, of course, given the disciplinary origins and traditions of course designers, and the academic conservatism and orthodoxy whch can sometimes exist in institutions of higher education. Rather similarly, students who have been generally less steeped in disciplinary cultures than their lecturers seldom jettison a disciplinary perspective even after three years of undergraduate study, if project titles, option choice and examination responses are suitable indicators.

Arguments for and against integration continue to be stated for different levels of curriculum design (Heathcote, Kempa and Roberts, 1982). Points in favour of integration in environmental courses include the opinions that any one discipline is inadequate to understand the operation and functioning of environmental systems; the constant change and rapidity of societal and technological development in the modern world require new and different vocational, personal and technical skills which are better achieved through interdisciplinary training; the training of experts and decision

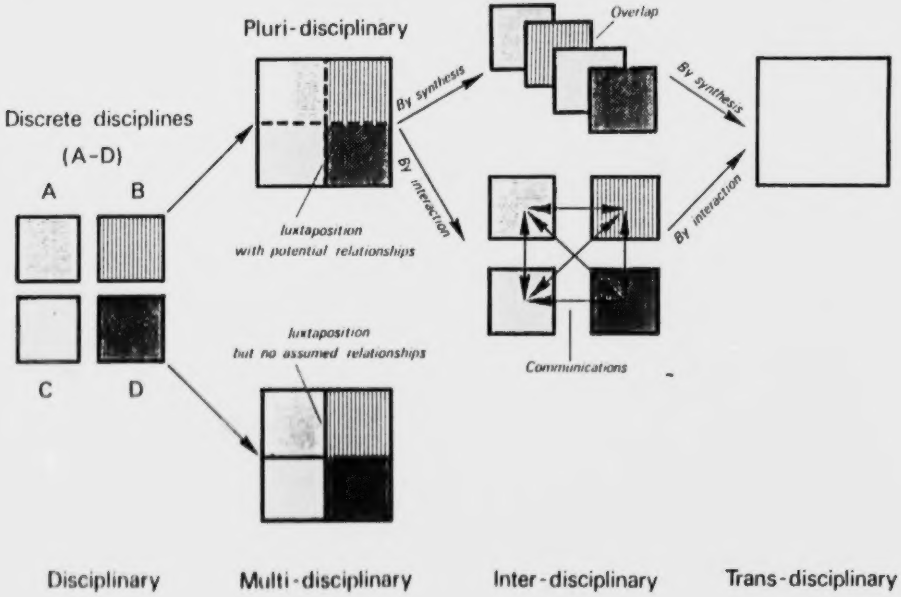
Discrete disciplines
(A-D)
A
B
C
D
Pluri-disciplinary
Juxtaposition
with potential relationships
Juxtaposition
but no assumed relationships
By synthesis
By interaction
Overlap
Communications
By synthesis
By interaction
Disciplinary
Multi-disciplinary
Inter-disciplinary
Trans-disciplinary

FIGURE 1

makers should stress more 'holistic' thinking to counter alleged 'tunnel' vision of some subject-centred specialists.

Against these points, however, there are cogent counter arguments, based on the view that integrated courses dilute standards, reduce 'rigour' and encourage superficiality; run counter to the increasing sophistication and refinement required by modern society, industry and economy as reflected in the demand for specialists rather than generalists; create artificial links which are not really critical in scientific analyses and which confuse and produce complexity rather than simplify and enhance explanatory powers.

Without pursuing this particular debate here one of the great tensions in environmental education is clearly the balance between intense specialisation (which involves disaggregation of knowledge) and the opposing trend of general synthesis. The former requires the disaggregation of phenomena for analysis; the latter, integration, to counteract the breadth, ecomplexity and heterogeneity of environmental data. Whilst many courses pay lip-service to integration, some commentators for example (Newbould, 1975) are doubtful if integration in environmental courses is as successful or as complete as is claimed. Probably this criticism has been mounted because the mechanisms to achieve integration have not been as comprehensively considered in practice as they might have been. These mechanisms are now examined from three related and overlapping viewpoints: academic content, teaching approach and organisation.

ACADEMIC CONTENT

Usually, procedures to achieve interdisciplinarity and to stress interrelatedness of phenomena start with subject matter. This level of integration is the most basic. It is obviously easier to achieve in cognate disciplines than between unrelated disciplines or between the natural and social sciences where traditional problems of communication exist.

Conceptual and methodological connections between subjects have long been recognised and deliberately encouraged, but some of these are of theoretical and philosophical interest rather than of real practical value. Lars Emmelin in his valuable survey of environmental courses in Higher Education and in his subsequent critical commentary (1975) on the integration idea, lists a range of unifying methodologies. Many of these such as general system theory, entropy, energy, have developed originally in traditional disciplinary areas such as biology, mathematics and economics, and have a proven high degree of transferability, emphasising links and overlap rather than boundaries between subjects. So far, no such methodologies can truly be attributed and called indigenous to environmental studies/science; indeed it may be questionable if any will emerge. Perhaps because of that, the search for a common core continues.

In the absence of a clear and commonly accepted conceptual basis for subject content integration, many environmental courses rely on selected 'extrinsic foci' or themes as the basic mechanisms for integration. These are usually expressed in the form of a number of recognisable topics such as pollution, conservation and community planning, characterised by a strong contemporary bias and variously applied along the local-global spectrum.

Many courses utilise these foci as their building blocks, arranged in such a way that suits particular objectives and educational goals. Structural frameworks have to be designed and tailored specifically to allow integration between foci which, whilst constructing an overall unified programme, still allows the foci to develop their own level of sophistication and flexibility. The challenge, of course, is to organise these in such a way that they form a coherent whole and are not merely multi-disciplinary packages. This challenge gives scope for considerable creativity and opportunities for innovation, a challenge which unfortunately is not always met.

A danger is for the foci to be mere extensions of disciplinary empires, taught by specialists who may apply their knowledge to the study of the environment but who then withdraw, back to their departmental shell. 'Foci' may thus remain islands of intellectual endeavour, unintegrated and isolated unless deliberate attempts are made to relate their internal coherence into a wider whole.

Finally, though, it is not enough that curriculum is carfully planned or that it is coherent. For, as the OECD (1973) report notes:

> "It is not enough to define conceptual methodologies or even common themes and cores in order to impact a comprehensive integrative environmental studies".

It must be successful, practical and implemented. This requires consideration of the mechanisms of pedagogical integration, a dimension which remains in a cinderella state.

INSTRUCTIONAL PROCEDURES

Those who have the responsiblity of directing environmental courses know that structural solutions, designed to integrate content, remain paper exercises unless they are implemented with complementary, appropriate and effectively co-ordinated teaching approaches. Instructional procedures need to be carefully and sequentially arranged with respect to the foci of study, whether they be optional or compulsory to all participants.

Instructional procedures include varying amounts of exposition, experimental learning and teacher and student controlled learning. Most integrated environmental courses possess elements of all aspects but emphases are hard to assess and measure except where method is made more explicit as in some forms of assessment. Often little explicit attention is given to when and how these various didactic devices are to be utilised and integrated into the scheme. Sometimes different foci employ and operate different conceptual systems, technological practices, and assessment schedules. The reconciliation of discrepant methodologies is necessary to avoid confusion, repetition and duplication to the learner.

Traditional environmental courses in Higher Education place a high premium on the development of cognitive skills such as the acquisition of knowledge, problem solving, analysis, synthesis and so on. Usually, these are developed through teacher dominant methods of instruction, essentially lecture orientated which control the rate and type of learning, the format and sequence and the feedback required. New strategies and procedures have emerged reflecting some individualised, personalised, independent learning, some which may be computer assisted (Prowse, 1985). These styles of teaching need to be carefully co-ordinated and integrated into the whole scheme.

Furthermore, if an aim of environmental education is to change attitudes and behaviour, other objectives promoting awareness, interaction skills, managerial leadership qualities, collaborative abilty and so on, need to be consciously developed and incorporated. The OECD (1974) argued for a broadening of pedagogic approaches involving more emphasis on learning than teaching, more on the process of environmental education than on the content and more controlled by the learner than by the lecturer.

This shift would also be consistent with the belief that environmentalism has to be lived and acted upon (O'Riordan, 1981). It may require lecturers to complement their formal approaches to teaching with informal perspectives. One way this can be achieved is by harnessing the potential of students themselves, many of whom have valuable environmental backgrounds and experiences and are sources of information and skills in their own right. The interaction generated by sharing the knowledge, resources of skills of staff and students, in both formal and informal senses, can be one of the most exciting facets of environmental education.

These new emphases in learning naturally lead one to recognise more fully the value of involvement and action in 'real' issues, often most readily found in the local community. This characteristic is urged by a number of workers (e.g. Llewellyn, 1985) and organisations both at the world level (Green peace, F.O.E. (International, at national level or at local levels (B.T.C.V. (North East)), either along professional or voluntary lines. The integration of community based learning, based on participation, involvement, and even action is not new and is clearly attainable through project work, field work and collaborative research, so long as

1. a flexible structure operates;

2. staff have the time and the inclination to make it work.

To implement more widely the new styles of learning noted above, involving sometimes radical alternatives and departures from traditional approaches, requires change in the roles of tutors and staff in relation to students. Staff need to adopt unfamiliar roles; no longer are they seen as 'gurus' transmitting the environmental gospel and monopolising truth and reality. Rather they may become managers of educational experiences, subordinating their disciplinary loyalties to the needs and demands of integrated interdisciplinary learning.

ORGANISATION

To achieve the educational and academic goals of environmental education requires a high level of organisation. Integration in environmental courses for example has to be constructed de novo, and reconstructed and modified over time. It is a slow process not just because of the vagaries of higher education push-pull which affects innovative forms of learning, but because of the complexity of the organisation involved.

Organisation of integration is usually left to a co-ordinator and a group of colleagues in key positions who undertake delegated responsibilities for different components of the course, and ensure that the wider teaching team is familiar with preferred policies. The co-ordination of effort in this pyramid of organisation is vital if integration academically and educationally is to succeed (Roby, 1982).

Two strands/aspects of this organisational problem relating to staff can be separated. The most basic relates to communication, especially where interdepartmental and interfaculty boundaries are crossed. Too much communication in the form of memorandums, meetings and telephone calls fails through over-organisation. Too little means that important decisions and policies are not fully implemented.

The second aspect to organisation, irrespective of the quality of communication instigated by the course co-ordinators, relates to the extent to which the teaching team is committed intellectually, educationally and emotionally to the ideals and practices of environmental education. Staff, of course, cannot be expected to undertake workloads beyond the accepted norms or which interfere with commitments to other courses. Unfortunately, the heavier organisational requirements of integrated schemes can result sometimes in the reduction of staff involvement, accessibility or availability.

The cost of organisational integration ultimately fall on the student as the receptor and consumer. Students who are often highly motivated and who are anxious to maximise their goals and ambitions are particularly critical of lapses in organisation and poor communication between staff, especially where they perceive little effort has been made to integrate their efforts.

It is fortunate that in England there is considerable freedom to implement new skills and schemes of integration and to innovate.

Innovation is encouraged by the national competition amongst courses and institutions for students and resources, the latter especially in times of contraction and uncertainty. It has also been promoted in the public sector by CNAA who, whilst seeking to foster academic excellence nationally, has always encouraged innovation in individual institutions, including forms of interdisciplinary teaching. This is easier in theory than practice especially under the pressure of stringencies, contraction and conservatism in 'hard times' (Studdert-Kennedy, 1976), it after assumed that the successful operation of new forms and styles of integrated learning requires more effort and time organisationally.

The following case study of a B.Sc. (Honours) course in Environmental Studies is used to exemplify some of the theoretical points noted above.

The Sunderland Model

The B.Sc. Course in Environmental Studies at Sunderland seeks explicitly to integrate its curriculum (Sunderland Polytechnic, 1984) and has been grappling with problems of content, approaches and organisation for over a decade. It has experienced continual change, refinement and indeed experimentation over this period in its search for the integration ideal. The course can be described as one of Emmelin's (1974) overview courses, and claims (probably extravagantly) to be fully integrated. In the eyes of some students it is not as integrated as some staff believe it to be and it certainly requires a wide range of academic, educational and organisational tactics to prevent multidisciplinarity from overshadowing interdisciplinarity.

Academic content is structured around two main compulsory units (Figure 2) which are intended to provide horizontal integration in each year. These two units are entitled Techniques (1) and Environmental Issues and Policies (2). The former contains generic quantitative methods using a system and modelling methodology, and in Year 2, management skills and appraisal techniques. The latter promotes and guides discussion on topical, controversial and relevant topics and parallels the sequential devleopment of knowledge acquired in systematic units which make up th rest of the programme.

These 'foci' units (A-D) are based on traditional fields of knowledge in Year 1 relating to the natural, physical, life and social sciences. In year 2 after a short period of contextual, interdisciplinary material, optional units derive from and evolve out of the contextual base. Students may select any 6. These foci then become more specialised and particular in Year 3 (4 from 7) around themes which harness the resources available and which have proven vocational value to our students. The whole system of material takes the form of a pyramid with a broad base in Year 1 and the apexes in Year 3.

It has to be admitted that most of the final year optional units can not yet be described as transdisciplinary biases. Some, however, have developed particular styles which espouse no discipline although they

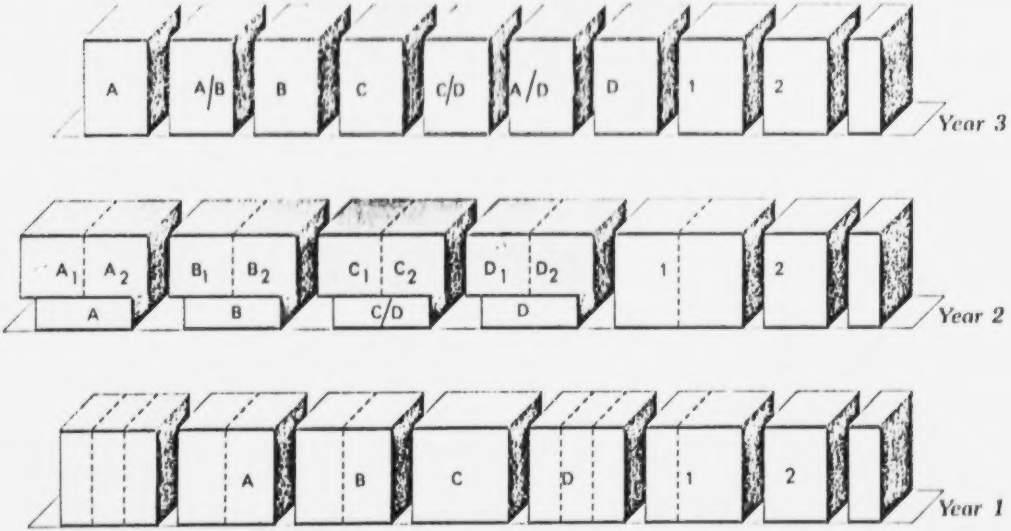
A
A/B
B
C
C/D
A/D
D
1
2
Year 3
A1
A2
B1
B2
C1
C2
D1
D2
A
B
C/D
D
1
2
Year 2
A
B
C
D
1
2
Year 1

FIGURE 2

borrow more heavily from some than others. The juxtaposition of units in Year 2 in pluri- and inter-disciplinary forms has still to be fully tested.

Even so, the scheme allows flexibility in its balance between generalisms and specialisms and in the pathway students may choose to satisfy their aspirations, interests and enthusiasms.

To integrate and co-ordinate the various contents of these foci into a unified structure we need to return to the two central axial compulsory units: Techniques and Issues and Policies (Figure 3). Whilst both central their integrative roles have rather opposing roles: the former is designed to prepare students with skills, quantitative and non-quantitative - at appropriate places to be utilised by the systematic units. This raises the difficulty of identifying and selecting the precise skills, and their level and timing, given the gestation period required between acquiring and applying knowledge.

On the contrary the Issues and Policies unit seeks to integrate the subject matter of the foci and apply it to selected problems and issues at appropriate local, regional and global levels. It therefore, 'imports' material from the systematic units in contrast to the Techniques unit. The Issues and Policies units traditionally counter the specialist emphases of the foci units seeking to apply them and discuss their environmental relevance.

A further integrative tactic and extension of the role of Issues and Policies is embodied in that section of it which is described 'Environmental Education and Information'. This is a new element introduced to improve and extend the literacy of students in the nature, philosophy and practices of environmental education. We have chosen to try to achieve this by boldly adopting an innovative approach which merits further comment. This unit, is presented in two halves. The first half (Term 1) is unique to each cohort of students and includes material required and relevant to the learning process in that year. It includes library search skills, report writing, project preparation and study methods. It also includes career information and training as described elsewhere (Blair and Dugdale, 1985). The second half (Term 2) brings students of all years together and centres on topical environmental reports, conferences, agencies and organisations and disasters. It has a high level of topicality, harnessing the experiences of students, staff and guests, as well as permitting spontaneous events, such as disasters, to be properly incorporated it is thus non-linar in structure. Since it involves all three cohorts of students, its material has to operate on a three year cycle to avoid duplication.

This creates a mechanical problem overcome, hopefully, by developing further perspectives of the same major issue or topic in a progressive way. Since this unit has only operated for one cycle so far (1984-85) it is impossible to comment upon either how far this can be success-

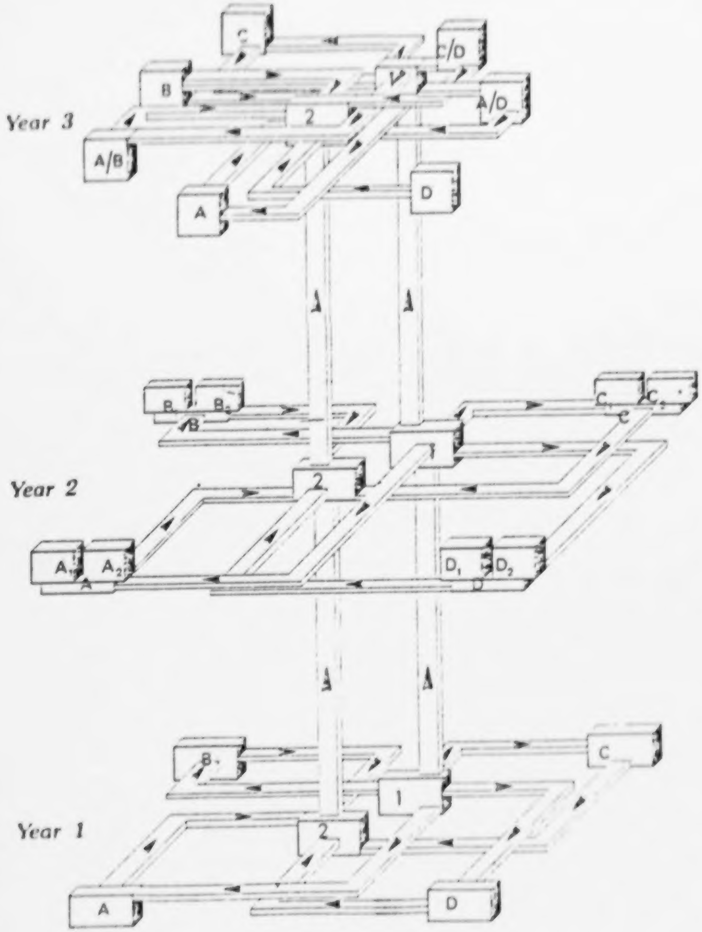
Year 3
C
C/D
B
V
A/D
2
A/B
A
D
Year 2
B1
B2
B
C1
C2
C
1
2
A1
A2
A
D1
D2
D
Year 1
B
C
1
2
A
D

FIGURE 3

fully implemented or how far the integration of students at different levels of learning can be achieved. The unit, therefore, is highly experimental and innovative. It is believed that such styles of innovation is consistent with the idea of integration and with the nature and philosophy of environmental education.

The scheme thus outlined embraces, it is believed, the ingredients of environmental education as perceived by Park (1983). It also seeks to deepen factual knowledge, extend technical and managerial skills and develop awareness based on rational and justifiable philosophies (O'Riordan, 1981).

In the implementation of a 'fully integrated' scheme, however, there remains the role of instructional and organisational procedures which we have stated are as fundamental to integration as more factual content. We are conscious of the need to reduce expositon especially in units where learning is better and more efficiently achieved by alternative methods. Similarly new forms of assessment are now included as part of a coherent learning strategy, and,in parts,no assessment at all.

From the student viewpoint, projects both major and minor can be, if properly structured and implemented, a valuable vehicle of intergration through their synthesising function and their value in providing a focus for the proper understanding of the subject matter of the course with a heavy involvement of the learner rather than the teacher.

One difficulty of learning and teaching formally integrated environmental schemes, however, is the lack of material available in appropriate published form. Another is the dearth of research to provide designers with the knowledge, experience and confidence to adopt new styles and roles. A third challenge relates to the continuing and growing demand for recurring education in society, which in its own right, generates new and different problems for integration. These obstacles exemplify the need for continually monitoring the shifts required in integrated education.

The involvement of students in 'outside' and informal contents of environmental education is in its infancy in Sunderland but is recognised by some as having particular value in helping to interpret theory and practice. A noticeable trend is the increasing desire on the part of students to undertake 'active' roles in voluntary community schemes. In 1984, for example, Environmental Studies initiated a series of practical conservation activities in collaboration with Tyne and Wear Council as part of their informal environmental society's programme. These were modest in scope and extent but provided considerable potential for continued development. Already another proposed form of collaboration between an outside agency and the students has been offered for 1985/86 which will involve practical management, research and involvement. In both cited cases, past students, now employed in positions of responsibility, have been important promoters and facilitators.

A different and more ambitious idea is now being discussed with the Borough of Sunderland with a view to the course formally and informally becoming involved in an urban park. This open space, about 50 hectares in extent is based on a natural 'dene', surrounded by housing and industry, and set in an area which is considered environmentally deprived. Hylton Dene, as it is called, features in the exhibition at this Confernece. It offers exciting potential for environmental study in both physico-ecological and socio-environmental senses, since it lies in an area which can attract urban aid grants from both the U.K. Government and EEC. Course involvement is being encouraged to provide research data, management proposals, conservation practice and community education ideas. So far a photographic survey has been undertaken by a researcher and preliminary meetings held with Landscape Architects and Planning and Parks Departments. Discussions with other interested environmental agencies and local community groups are planned in the coming session. It is intended initially to integrate this work formally into the course at appropriate places this coming session and to expand staff and student's informal links through the course's environmental society.

The successful inclusion of these materials and opportunities, and others offering tremendous potential for integrated environmental learning, depends on the flexibility of the course design and on staff attitudes. As with all integrated schemes there is the perennial problem of staff involvement and commitment, especially in work which tends to ignore firm timetables and which may be perceived to do little for career advancement. Of course, not all staff find integrated schemes intellectually satisfying and pedagogically interesting and prefer to rest in more comfortably defined subject areas.

These problems are especially acute in inter-faculty courses where staff are controlled and shaped by departmental policies which, especially in time of contraction, naturally favour indigenous research and teaching commitments in preference to inter-departmental and inter-faculty programmes.

It is to be expected, therefore, that individual staff see promotion and advancement through departmental channels with longer-established disciplinary traditions than through interdisciplinary interdepartmental endeavours. What is surprising perhaps is that progress in the latter continues to be made, albeit in the face of resource and other obstacles.

The promotion of integrated learning rests heavily on those with co-ordinating and organisational roles. Such leadership is, however, usually only assumed on a temporary basis and is accordingly never more than primus inter pares (Simmonds, 1976). It usually has little real statutory power in the allocation of resources and in the major decision-making area.

The ultimate success of any integrated environmental scheme rests as much on the strengths and commitments of the staff and students as on the commitment of the institution.

CONCLUSIONS

This paper has concentrated on the problem of translating the general goal of integration into practical education action. Whilst recognising the great diversity of degrees described as environmental it assumed that most courses grapple with very similar problems.

The difficulties of achieving full integration in established institutional structures are considerable and involve structural, procedural and attitudinal considerations.

Academic arguments still rage on whether or not coruses based on knowledge, material and techniques distilled from various disciplines are sound intellectually at Higher Education level. Where they have been accepted and developed, the search for tactics to integrate subject matter continues and no single profile is universally accepted.

Integration in environmental programmes require substantial changes in methods of teaching and learning in order to capture the relevance, dimension and complexity of real-world problems. The amount of time spent on scientific analysis, philosophical discussion, practical and community involvement, exposition and experimentation varies considerably according to individual and disciplinary perceptions.

Unless staff, students and institutions are fully committed, integration of environmental studies/sciences remains a paper exercise. Interdisciplinary courses are difficult to mount unless their special skill and status are acknowledged.

Exemplification of various styles and mechanisms of integration have been provided by reference to experiences gained at Sunderland Polytechnic. These have been interpreted personally by the present course leader to provide some insights and thoughts on the challenges and opportunities awaiting us over the next decade.

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INTEGRATING ENVIRONMENTAL STUDIES: EXPERIENCE AT NEWCASTLE POLYTECHNIC

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INTRODUCTION

Any course team teaching Environmental Studies or Environmental Science (E.S) must come to terms with the issue of interdisciplinarity for two major reasons: firstly because any unidisciplinary view of environment must inevitably be partial and secondly because our own training has been in almost all cases, unidisciplinary. Hausman (1979) identifies two types of interdisciplinary work; artificial that is designed for administrative convenience and natural, that is interdisciplinarity which develops because the object studied necessitates it: the environment very clearly demands interdisciplinary study. Since our training has been in other forms or fields of knowledge (Hirst 1965) we need to consider the extent to which we need to modify the methodology and content of these disciplines if we are successfully to use them to E.S.

THE NEWCASTLE APPROACH

This paper examines the response of the E.S. course team at Newcastle Polytechnic to the challenge of integrating our work. Edge (1975) comments "It is the nature of integrated courses that their content and methods tend to be unique to the particular members of the teaching group". It is not the intention of this paper to suggest that E.S. should be taught this way; institutional differences alone would be likely to lead to different responses by other course teams. Furthermore interdisciplinarity has its own momentum and the picture presented can be true only of one point in time. It is of course possible (Berger, 1975), (Kockelmans, 1979) to identify a spectrum of levels of integration ranging between the multidisciplinarity characteristic of many joint honours courses, in which there may be virtually no links between the major components; and the fully integrated course which may mark the development of new discipline in its own right. Over a period of time, we may expect curriculum development in E.S. to be in the direction of fuller integration, if only because the academic world equates disciplines with quality and as (Scott, 1979) stresses "economic, social and institutional frameworks support disciplines". Here of course is a paradox: E.S. courses tend to be peculiar to those who devise them yet respectability is earned through the monolithicity of established disciplines with "certain generally agreed upon canons and standards" (Kiger, 1971) implying convergence not merely of subject matter, but of philosophy and methodology.

E.S. has been taught at degree level in Newcastle Polytechnic since 1977 and is in its second quinquennial cycle of CNAA approval. It is run as an inter-faculty degree, though with its base in and the bulk of its teaching provided by the School of Geography and Environmental Studies. Four major groups of staff contribute to the degree: geographers, ecologists, chemists and the S.T.S. (science, technology and society) group, but support is also given by physicists, mathematicians and an economist.

It is difficult to distinguish the effects of subject-loyalty from that of the personal qualities of the staff involved, but it seems generally true that the contributing groups of staff have, initially at least, differing propensities to accept the need for integration. At one extreme S.T.S. and geography are strongly predisposed towards integrative work; in the case of S.T.S. the rationale for their existence is that of the need to explore the boundary between disciplines; Geography, as a field of knowledge has notoriously permeable boundaries (and seems most successful when borrowing or poaching from other areas of study). Ecologists, too, are likely to adapt quickly to interdisciplinary work because the central focus of their study, the ecosystem, demands an holistic view of the environment, including man and his activities, and they make use of the methods of a variety of other sciences. Physics and chemistry lie at the other extreme, having powerful methodologies and in (Bernstein's, 1971) terminology are strongly 'framed' with a tendency to 'insulate' themselves from other areas of knowledge, notwithstanding such established interdisciplinary studies as biochemistry and biophysics.

A priori it would seem that integration would be easier in some areas of the degree and that it might be expected to occur more rapidly in those areas; and to an extent this has happened, though with some interesting exceptions. Accepting the Nuffield Foundation 1975 definition of interdisciplinarity as "two or more disciplines are taught in conscious relation to one another" it is clear that a number of different forms of integration may occur within a course. (Harvey, 1977) for example distinguishes between the possibility of an environmental degree being integrated and one of these components within it being integrated. Within the Newcastle Polytechnic degree are two types of module; those which attempt to serve the interdisciplinary aims of the degree and those which are essentially propaedeutic, that is, are necessary precursors to another section of the degree. Maths and computing are in this latter category, intended to serve other modules, in particular final year projects. It was originally intended that a first year course in economics would serve such a purpose, but in the event the member of staff concerned has an active interest in and experience of environmental planning, so that later tutors find that students have not merely achieved some competence in rudimentary economics, necessary to an understanding of for example cost-benefit analysis, but that they have looked at a range of environmental planning issues from the economist's viewpoint, to the extent of doing fieldwork in environmental economics - an unexpected bonus in terms of interdisciplinarity. Early stages of, for example, environmental science are taught in the propaedeutic mode, with environmental meat being added to the bones of the discipline in the later stages of the course.

Within many of the specialist course modules a move towards more environmentally-relevant material - a form of curriculum drift - has occurred during the last eight years. Modules which initially aimed to teach the nuts and bolts of the discipline now focus much more directly on environmental issues and problems. In S.T.S. for example, detailed consideration of E.I.A. (Environmental Impact Assessment) has replaced environmentally neutral material. Similarly the second year human geography course has abandoned concern with theoretical models of settlement patterns to investigate geographical resources and population. Ecology has developed an interest in environmental management.

Such changes in curriculum are almost entirely caused by the desire of module tutors to make their courses more relevant environmentally. It might be argued that such changes do not reflect interdisciplinarity but merely a search for relevance. Two reasons, however, lead one to see them as indicators of interdisciplinarity: firstly, they provide evidence of willingness to abandon traditional curriculum content and secondly because these developments necessitate co-ordination between hitherto separate curriculum areas as, for example three specialists show an interest in E.I.A., four or five in aspects of resource management and four or five in hydrology.

Such demarcation disputes are not new within the degree but one reason for their becoming evident, apart from curriculum change, is almost certainly the informal exchange of information which becomes more frequent as a course becomes established. Give and take necessary in interdisciplinary work is much more easily achieved when informal contacts and a relaxed atmosphere allow an escape from (Bernstein's, 1971) "long socialisation into subject loyalty". In (Goodlad's words, 1976) " a discipline is as much a social phenomenon as an intellectual one".

Until subject boundaries yield, probably the best that can be hoped for in terms of disciplinarity is that for which the image of bridge building is most appropriate - a model implying the development of links only after firm disciplinary foundations have been laid - possibly very late in the degree. An alternative image (Nuffield, 1975) is that of restructuring, in which integration may be achieved ab initio.

Such an attempt is made in the Integrated Environmental Studies I.E.S. course which forms the core of the degree. It is the successor to a series of interdisciplinary seminars, in which integration was attempted through consideration of a number of topics selected by different members of the course team. On occasions such topics might spark off discussion and interest but the episodic and eclectic nature of the course was not sufficient: clearly a structure is needed to hold such topics together. Furthermore, a course was needed to develop the students existing interest in both broad and narrow environmental and environmentalist issues. Originally, it was hoped that the module could be larger than its present three hours per week, to allow detailed elaboration of, for example, the chemistry of water pollution at the appropriate stage. In the event disciplinary shutters rattled down.

The three parts of the three year I.E.S. module are of unequal length. An introduction investigates perception of environment and attitudes to environment. Classic environmentalist works are introduced, and a selection of environmentalist groups, such as Friends of the Earth and for contrast, the National Trust are investigated. "Understanding the Environment" examines a selection of paradigms used in analysing man's relation to environment and "Environmental Crisis" looks at environmentalism as a movement and at environmental future scenarios. An important function of the first part of the I.E.S. module is to maintain and stimulate an interest in environment at a stage of the course when links between disciplinary modules are tenuous. At this stage, students must take it on trust that component disciplines really do help to understand environment. Discussion of for example plots to save the world, Hardin's "Tragedy of the Commons", Aldo Leopold's environmental ethics, or Thoreau's reverence for nature, allow students to feel that they are in contact with real and important issues and that their opinions on these issues are valid.

Part II of I.E.S. comprises a number of major studies of natural resources: minerals, water, food, land and energy. Of these the energy element is studied for almost a year, reflecting the contemporary importance of this resource and the existence of considerable staff expertise. By considering the environment as a resource and hazard we ensure a focus on both man and environment. Emphasis on detailed case studies enforces a consideration of environmenatl systems "in the rough"; the world as it is, rather than as a refined disciplinary abstraction. Teaching is done by a limited number of staff, who for much of this section, share seminars. Such a pattern of working achieves continuity and the team teaching element serves as an educative tool in itself, encouraging the development of shared research, such as recently published investigation of nuclear waste disposal proposals in the Cheviot Hills. A series of these studies have been developed for teaching the module.

Case studies are selected for their value as spurs to interdisciplinary work and are selected to cover different scales between the global and the very local and to vary between those which concern the future of mankind and of a wide range of organisms; topics such as deforestation and precipitation and water pollution; and those which concern much more subjective issues of taste and aesthetics, issues such as threats to landscape quality caused by modern agricultural practices and woodland management policies. Such environmental threats may be keenly felt and involve value judgements. In the one case scientific investigation and the logical positivist model is valid, in the other a subjective behaviourist model is needed. Knowing which technique is relevant and the limits of its effectiveness is an essential interdisciplinary element.

As students move through the course, their increasing understanding of contributary disciplines allows a richer experience of the case study material. This is particularly true of energy resources where a careful interdigitation of work in Environmental Science and S.T.S. supports work in I.E.S.

Section III of I.E.S. comprises a review of some of the major themes in E.S. - conservation, preservation, pollution management and of some of the issues first raised in part I. Again, detailed case studies are used, with an attempt to develop the student's awareness of the institutional framework for environmental management in the UK and the EEC.

Assessment of the I.E.S. course is through coursework and by a traditional examination. One element of Year I and Year II exams which might be extended in future is a series of data response questions, in which material taught in the course is used, in conjunction with varying amounts of statistical and mapped data to answer a series of questions, some closed and others open-ended. Some of the data is of deliberately limited relevance and all has been of differing levels of reliability, in an attempt to replicate the untidiness of real world problems, using sub-optimal information. Such questions may entail considerable research in their preparation.

CONCLUSION

Student views on the I.E.S. course elicited through questionnaires and informal discussions have been generally laudatory. They have approved the general notion of the module, and criticisms have been restricted to details though with no clear pattern of complaints against any particular element. Experience of teaching the I.E.S. course suggests that at the moment, the most successful parts are those in which values and opinions are involved.

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MONASH MASTER OF ENVIRONMENTAL SCIENCE PROGRAM

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INTRODUCTION

Linke (1979) has commented that the development of environmental education in Australian tertiary institutions has been at least as extensive as that in primary and secondary schools, and probably more diverse. This diversity was related to the variety of specialist programs, the institutional autonomy available at the tertiary level, and possibly to the number of courses which incorporated discussion of environmental factors (such as zoology, geography and law). A survey of tertiary environmental programs carried out in the early 1970s and reported by Linke indicated a wide variety of courses in established disciplines and specialist areas in which consideration was given to the interaction of People with the environment.

The survey also noted the development of courses that were specifically designed for environmental education. This kind of course, promoted by the Organisation for Economic Co-operation and Development, provided environmental education based on basic disciplines; integrating themes leading to interdisciplinary relevant problems and practical, real-life, local projects (OECD, 1973).

In this context interdisciplinary was defined as the interaction between two or more disciplines.

With regard to postgraduate courses, Linke noted two characteristics shared by the programs surveyed (a): an emphasis on practical application of theoretical principles to environmental problems, and (b): encouragement of students to work in specialist teams. In response to the recognition of the need for postgraduate environmental education, and possibly because it was fashionable, eleven master's programs were begun in the 1970's in Australian institutions. There is substantial variety in organisations, administration and approach of these programs.

MONASH MASTER OF ENVIRONMENTAL SCIENCE PROGRAM

Form, Structure and Objectives

In 1973 Monash University enrolled the first master's degree candidates in environmental studies in Australia. Since that time almost half of all Australians holding master's degrees in this field (over 140) have graduated through the Graduate School of Environmental Science (G.S.E.S.) at Monash University.

The G.S.E.S. is administered by the Board of Studies in Environmental Science which monitors student matters and the day to day administration of the M.Env.Sc. program. The Board includes representatives from all faculties in the University, industry, government departments, present candidates, and a graduate of the course. This body reports to the Standing Committee in Environmental Science which attends to budget and academic standards and is a standing committee of the Professiorial Board, consisting of the three Deans whose faculties are most involved in the course, plus the Chairman of the Board of Studies.

The M.Env.Sc. program requires two years' full-time, or up to five years part-time study, and has been designed to achieve several aims; i.e.:

(a) to enable candidates to continue studies at graduate level within their areas of interest and/or previous training;

(b) to facilitate candidates broadening their experience and awareness of environmental conservation, resource management and environmental planning;

(c) to provide candidates with experience in carrying out a research project on an environmental issue in a multi-disciplinary team.

(d) to enable candidates to work and communicate with staff and other students who hold degrees in a diversity of disciplines;

(e) to facilitate candidates developing a sensitivity to the complexity of the world system and a caring and responsible stance toward it. (G.S.E.S. 1985).

Graduates should be capable of contributing their own specialist skills within a team approach to environmental issues and be able to interpret and apply the findings and recommendations of other professionals. To achieve this the program has two main components. The first involves coursework which candidates undertake. Each candidate selects an individual program from some 150 subjects drawn from all faculties of the University. These subjects fit into the categories of:

1. foundation studies, which are obligatory for candidates with insufficient background in these subject areas;

2. core studies, which are obligatory for all candidates, and

3. elective studies, from which candidates select subjects as background for their research, career needs and general interest.

The second component of the program is research including both multidisciplinary and individual research. Multidisciplinary research involves candidates in two core subjects, Multidisciplinary Organisation and Environmental Research Methodology.

The Players

i) Candidates

A maximum of 140 candidates are admitted with either a four years' bachelor's degree (or equivalent) in any discipline, or a three years' bachelor's degree (or equivalent) plus two years' suitable work experience. In selecting candidates about equal weighting is given to their academic record and to their work/world experience and motivation. As a result its student body has:

(a) many mature students (median age in first year, 25-30)
(b) many part-time students (about 70 percent)
(c) a predominance of man (about 70 percent)
(d) students from many disciplines and backgrounds. (Table 1). The degree has proportionately fewer natural scientists/engineers/architects than graduates in humanities. Also there is continuing strong interest from teachers.

All candidates are members of the Master of Environmental Science Students' Association which contributes to course development, represents candidates in negotiations over working conditions and organises a social program. Representatives attend staff meetings and represents current students on the Board of Studies.

ii) Staff

The director, two full-time lecturers and three part-time lecturers (norminally 0.5) make up the academic staff of C.S.E.S. Their backgrounds cover zoology, engineering, agriculture, land use planning, sociology and environmental science, and they have experience of employment in state and local government, secondary and tertiary teaching, private industry and consultancy work. Their ages range from early thirties to late fifties.

iii) Student Expectations

The variety of people attracted to the program, coupled with the range of opinions about 'environmental science', has led to a diversity of expectations. The objectives are not the only expectations (Table 2). However, of the four most frequently noted expectations ((e)(f)(i) and (l)), three correspond to the programme objectives.

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Field Sciences (Geography, Biology, Agriculture, etc.)	9	23	26	17	16	17	24	19	22	24	36	26	20
Natural Sciences (Physics, Chemistry, Maths, etc.)	33	32	33	53	42	22	20	25	30	24	18	29	13
Medical	-	6	-	-	-	6	-	-	4	3	5	2	3
Engineering/Architecture/ Planning/Surveying.	19	23	14	20	21	22	18	11	6	9	14	12	10
Social Sciences (Psychology, Economics, Sociology)	23	-	-	3	5	5	8	15	14	10	13	6	17
Humanities	14	16	24	7	11	22	24	26	22	30	5	24	37
Law	2	-	3	-	5	6	6	4	2	-	9	2	-
Total Numbers	42	31	29	30	19	18	50	57	67	33	22	42	30

TABLE 1 Disciplines of Candidates by Year of Entry
(Figures are % of candidates in the designated discipline)

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Teaching (School, Tertiary)	36	45	17	37	33	17	40	42	34	36	27	24	30
Planning/Management	5	10	20	13	11	28	16	7	7	6	9	12	20
Resource Development	-	-	3	13	-	-	2	2	-	3	-	5	-
Medical	-	6	-	-	5	-	2	2	6	3	-	-	-
Engineering/Architecture	12	6	14	10	16	17	10	7	4	6	14	5	10
University Research	-	3	7	-	-	-	2	4	-	-	-	-	-
Other (unskilled, skilled, professional)	19	23	17	23	32	22	20	32	37	30	45	43	30
New graduates	28	7	22	4	3	16	8	4	12	16	5	11	10
Total Numbers	42	31	29	30	19	18	50	57	67	33	22	42	30

TABLE 2 Employment Areas of Candidates by Year of Entry
(Figures are % of candidates in the designated employment areas)

HIGHLIGHTS OF THE M.ENV.SC. PROGRAM

Coursework

i) Philosophy

The major thrust of the program is to provide candidates with the opportunity to appreciate the complexity of the environment, their part in it, and the variety of 'tools' used in management. Part and parcel of this is the need to encourage an understanding of how the various disciplines consider the environment so that this can gain an interdisciplinary insight. Since the definition of environment adopted by the program covers both physical and social aspects, candidates need to be exposed to many disciplines in a short time. To achieve this with some depth of understanding, candidates select subjects offered by almost all departments within the University. A specific program of coursework is developed for each candidate, through counselling, to ensure interdisciplinary exposure plus the study direction desired by the candidate (e.g. advanced study in some area, or broad ranging study).

Candidates usually complete 15-20 subjects (of variable weighting) from Foundation, Core and elective subject groupings. Most of the 150 subjects listed in the G.S.E.S. Handbook are taught by staff 'outside' G.S.E.S. usually as part of other departments' teaching programs. M.Env.Sc. candidates are expected to complete the same work as the other departments' candidates. Where there are no suitable subjects otherwise available, specific subjects are occasionally developed and taught especially for M.Env.Sc. candidates. The number of these subjects is kept to a minimum because of the desire to expose M.Env.Sc. candidates to both staff and students of other departments. Subjects specifically related to environmental investigation or designed for M.Env.Sc. candidates, such as the integrative Core subjects, are taught in the G.S.E.S.

This approach to coursework differs from most Australian programs in which either staff of the 'environmental department' present a limited number of compulsory subjects or staff of other departments are 'brought in'. The approach adopted by G.S.E.S. is intended to give candidates the maximum exposure to a variety of disciplines (both staff and students), offer a large range of experiences (subjects) with minimal G.S.E.S. staff and expose other departments to the M.Env.Sc. candidates.

ii) Foundation Subjects

Compulsory Foundation subjects have been designed to ensure that all candidates have a basic understanding of chemistry, ecology, mathematics, law and economics. Candidates are exempted from subjects if they already have sufficient background.

iii) Core Subjects

Flexibility to cater for individual requirements, has been encouraged by minimising the number of compulsory core subjects. These five subjects form only 24 percent of the coursework component but are required to 'tie together' the many loose threads of Foundation and Elective studies.

Core subjects demonstrate the interrelationships which are so evident in environmental issues. Two theoretical subjects (Science and Systems Theory, 1 and 2) require candidates to explore conceptions of environment using a holistic approach, while two practical subjects (multidisciplinary Organisation and Environmental Research Methodology) provide practice in applying interdisciplinary understanding to environmental problems.

iv) Elective Subjects

Most candidates have the opportunity to take ten or more subjects which are not required Foundation or Core subjects. They are guided in their choice so that they are exposed to a broad range of disciplines but can if they wish pursue studies in their basic disciplines.

Electives are primarily subjects already included in other departments' programs. However, some are organised within G.S.E.S.: either

(a) to provide specific knowledge/skills otherwise available in the university (e.g. Marine Science);

(b) to look at the enviornment from a particular perspective (e.g. Environment in Literature, Philosophical Issues in Ecology); or

(c) to provide additional examples of integrative and interdisciplinary studies (e.g. Conserver Society, Environmental Assessment, Environmental Assessment, Environmental Land Use Planning).

Multidisciplinary Organisations

i) Philosophy and Structure

Multidisciplinary Organisation grew out of the need to provide candidates undertaking team projects with training and experience for working multidisciplinary teams. This is provided in the year prior to candidates beginning their project and thesis and the emphasis is on practical examples or organising a project and working with people from different backgrounds (and disciplines).

Small teams of candidates, are required to complete specified work in a limited time. These teams effectively act as consultants to produce a report for a client/sponsor who may be the staff or the team itself, or a government department or private industry may fund the report. However, the learning experience is more important than the report.

Some guidance is given through lectures, but most assistance comes from discussion between staff and the teams, and criticism of material submitted. This type of interaction is obviously demanding of staff time and inspiration and, over time, the number of staff involved in the subject has risen from one to three. The commitment of more staff has been influenced by the increase in numbers of candidates but, more important by the desire to increase the opportunities for counselling or supervising individual teams and providing candidates with a wider range of opinions. The diversity of staff backgrounds means that they may give contradictory advice as in the real world.

ii) Organising a Project

The essential learning experiences in project work are discipline, organisation, methodology, communication and performance (i.e. the practical activities which are needed to produce a report for a client in a specified time). Over the 15 week course candidates are given lectures and notes on:

(a) organising critical path management schedules;

(b) project methodology;

(c) context and approach to interdisciplinary research; and

(d) aspects of report writing.

In response, each team is required to submit:

(a) a description of the proposed project; including the project objectives and discussion of how the skills of the individual team member fit with these;

(b) a project brief; to define the task, its context, nature and scope, what data would be collected and how it would be collected and analysed;

(c) a critical path management schedule;

(d) a preliminary report; which should indicate a depth of understanding and show evidence of interdisciplinary teamwork;

(e) a final report; which is clear, logical and understandable by a lay reader, and

(f) minutes of all team meetings.

Comments on this material are given to the teams the week after submission and teams have the opportunity to obtain feedback from each other.

iii) Group Dynamics

As noted earlier the difficulties candidates experienced in working in teams prompted the development of the Multidisciplinary Organisation component. The dynamics of group work, particularly with people of differing backgrounds, necessitate an understanding of both how people relate to one another and of individual requirements. These understandings are developed in the context of the team's project.

In conjunction with project organisation, a lecture on small group dynamics is given and the teams are required to submit group dynamics reports. As part of the agenda of team meetings, each team is also asked to reflect on how the team is functioning as a group and how each person feels he/she is functioning within the group.

In parallel with the project reports, group dynamics reports are required. Progress and final reports cover:

(a) description of the group, i.e. structural features (division of labour, meeting organisation), and group dynamics (patterns of interaction, evolution of group feeling, elements of harmony/conflict), and

(b) assessment of performance; i.e. how successfully the team organised itself and operated to realise the project objectives, constraints which reduced effectiveness and what was done about these (competing demands, available skills, language difficulties), and what could have been done collectively and individually to improve group effectiveness.

Group dynamics accounts for 17 percent of the assessment of this assignment.

iv) Student Response

Candidates provide feedback about this component of the course:

(a) in discussion sessions, when comments about approach of the staff or material covered are sometimes raised;

(b) more formally through the evaluation questionnaire filled in at the end of the subject; and

(c) in the team assessment session in the final week of the component when staff present their assessment of the performance of each team. This provides candidates with the chance to discuss differences with staff and frequently raises fundamental issues.

Multidisciplinary arrangements may be seen at first as 'something to be endured' but more positive feelings about its worth emerge and afterwards most candidates see the experiences endured as being useful both in their work away from the University and particularly in undertaking their research project in this degree.

Research Component of The Degree

i) Approach

The research component is undertaken in the last year of the degree:

(a) to provide experience in research on an environmental issues in a multidisciplinary team, and

(b) to satisfy the requirements of the University in respect of the ability to undertake individual research to a suitable academic standard and produce a minor thesis.

Initially it was felt that candidates could achieve both aims by writing joint theses, as is done in some other universities, however, this was considered unsatisfactory by the University and candidates are required to both contribute to the production of a multidisciplinary team project report and prepare their own theses.

ii) Research Project

The practical application Mutlidisciplinary Organisation training comes when the research project is undertaken in Environmental Research Methodology, another core subject, which involves the candidates working in project teams of two to five, representing a range of disciplines. Project topics are chosen to be relevant to immediate (real world) situations and are frequently sponsored by government departments or private industry. Strict deadlines and reporting procedures are followed so that work on the project approximates a 'work situation' as closely as possible. The specific aims are:

(a) to provide candidates with the opportunity to gain experience in formulating, investigating and reporting on an environmental problem or issue;

(b) to provide supervised, practical training in multidisciplinary team research oriented toward the development of an interdisciplinary perspective (building upon the coursework training);

(c) to provide opportunities for producing both an interdisciplinary research report in a form suitable for publication and an academically rigorous minor thesis,

(d) to provide, where possible, the practical experience of working in consultation with an external client to meet definite research needs, and

(e) to satisfy the Board of Studies in Environmental Science that the candidate has both contributed to the successful performance of a group research project and has completed an individual thesis at a level commensurate with the degree of M.Env.Sc.

The Multidisciplinary Organisation and Environmental Research Methodology courses provide the opportunity to practise, bringing together the threads of environmental research in relation to a particular task and to work with people from a range of disciplines, and is designed to help candidates integrate information.

Environmental Research Methodologies combines about 7 percent of the degree assessment but involves much more work that this. Students devote time to it because it is compulsory but also because involvement in multidisciplinary teamwork is one of the things which they expect of the course (see Table 3). Other incentives are that many reports (about 40 percent)are published by G.S.E.S. with authorship by the candidates, and the experience can help them to obtain employment.

A member of G.S.E.S. staff is appointed as the 'team supervisor' for each project and is assisted by a supervisory committee formed from representatives of the sponsor and the candidates' supervisors (one for each thesis).

iii) Minor Thesis

In parallel with this project work the individuals undertake a minor thesis, which constitutes 25 percent of the program requirement. Some candidates take their thesis area directly from the research project while others develop a project around the thesis topic which interests them. In both, candidates are encourages to use material they have individually contributed to the project as the basis of their thesis, to keep their work load within reasonable proportions.

Each thesis is undertaken within one of the faculties of the University (which faculty depends upon the topic chosen by the candidate) from where the 'individual supervisor' is appointed.

Initial expectations of how the degree program would be useful.

	Expectation, that the M.Env.Sc. would:	No. times noted[2]
(a)	help in obtaining a job.	36
(b)	help in changing jobs.	45
(c)	enable further studies in basic discipline.	30
(d)	enable postgraduate research.	36
(e)	broaden knowledge/understanding of other disciplines.	76
(f)	provide experience in interdisciplinary work	58
(g)	give practice in multidisciplinary team work.	47
(h)	provide opportunity to look at environmental problems in a practical way.	55
(i)	increase (candidate's) environmental perspective.	79
(j)	help candidate participate in environmental issues.	41
(k)	help candidate spread environmental message.	29
(l)	give another qualification.	69
	help with current job/work.[1]	5
	overcome candidate being 'pigeon-holed'[1]	1
	increase specific knowledge in new areas[1]	1
	gain a sense of personal worth[1]	2
	help integrate environmental and political perspectives.[1]	1

Notes: [1] Added by respondent under 'other' category.

[2] Respondents could indicate more than one expectation.

Source: May 1985 questionnaire sent to all M.Env.Sc. graduates of whom around 60% responded (82 of 143).

TABLE 3 Candidates' Expectations of Program

Integrator Training

i) A Concept Within the Program

In relation to multidisciplinary teamwork focused on practical environmental projects, the term environmental integrator appears occasionally. The case for 'environmental integrators' has been developed by Maldague (1977) in the context of training environmental professionals to understand environmental complexity, as distinct from being involved in specific aspects of the environment; for example water pollution. The suggestion is that whatever the type or level of 'professional environmental management education' the graduate should be specialised enough to contribute in field operation and broad enough to appreciate complicated human and other biotic phenomen.

To produce not generalists with no speciality but specialists with breadth, Maldague proposes that postgraduate training of environmental integrators should be provided (Maldague, 1977).

In the context of the M.Env.Sc. program, the approach to this training involves grafting specialised training on a course structure which requires students to obtain a breadth of knowledge and attitudes. Graduates are effectively environmental integrators who are expected to work within one or more of the traditional disciplines.

ii) Comments From Graduates

The integrator aspect of the program is not as explicit as multidisciplinary teamwork and it has not been clear whether this training has been useful to students. To check if this emphasis was achieving anything, a recent survey of graduates (March, 1985) included a description of an integrator and asked if they worked in this capacity. Of those who replied to this question, 55 said they had the opportunity to work as integrators and 19 said not. Those who operated as integrators,

(a) managed or co-ordinated people (usually from a range of disciplines, sometimes consultants) or projects (relating to a range of aspects e.g. planning and school curriculum) or organised individual research; or

(b) were involved in a multidisciplinary team (committee), in the development/analysis of policies/projects, needing to 'deal' with a variety of people (as in a business), or in developing training programs/material; or

(c) were seeking information or people (e.g. networking, drawing people together).

These responses indicate an awareness by graduates of the many and varied opportunites for interdisciplinary work. It appear from a survey of graduates in May 1958, that the program could be evaluated on a variety of criteria. However, many graduates found the degree helpful in their careers.

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THE DESIGN OF "LINK" COURSES IN ENVIRONMENTAL EDUCATION

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INTRODUCTION

This paper is a discussion of gaps in environmental education, primarily at University level but the principles considered will also apply at other levels, their impact on the success of environmental teaching, and ways of plugging them. The origin and nature of the gaps will first be identified. The concept of "Link" courses will then be introduced and discussed, and illustrated by reference to the course in Environmental Management developed in the Department of Environmental Science at the University of Lancaster. The paper will end with a review of the problems involved in the establishment of "Link" courses, and possible remedies, using the experience gained in the Lancaster course as a basis for the discussion.

DESIGN OF ENVIRONMENTAL COURSES

Environmental education has been considered to be "good thing" since its inception in the early 1960's, but there has never been general agreement on the best way to undertake it. This results, partly, from valid differences of opinion between individuals involved but, nonetheless, must also be an inevitable consequence of the vast amount of subject material that could be included in an "ideal" course. Such a course would have to include elements of pure and applied science, engineering, social science, and the humanities. In practice any attempt to institute such a course is precluded by limitations on course length, student aptitude and student interests; degree courses must be completed in three years, must be related to the probable abilities of applicants, and should recognise that they will have preferred areas of study rather than a global interest. These realities determine that University courses in environmental education (Environmental Science, Environmental Studies and other kindred courses) must of necessity be based on a careful selection of subject material.

The courses which have resulted show broad similarities in underlying principles and general content, but wide divergences in detailed content and structure. The common themes producing unification between courses are the desires to produce:-

a) an integrated and balanced treatment of the subject areas required to describe and understand man's environment, considered in physico-chemical, biological or human terms, and various combinations,

b) an appreciation in the student of the impact of the natural environment on man's activities, and vice versa,

c) the abilities to predict and control these impacts, when possible, and manage the man/environment interaction accordingly.

Courses developed in accordance with these fundamental aims are constrained by the need for selection, and have detailed contents falling in various portions of the total field of subject material possible. These relate to their specific objectives. This situation is shown schematically in figure 1. Some courses may be highly concentrated in a traditional subject area (areas 1 and 2 in Figure 1), others may combined elements of two subject groupings (areas 3 and 4) to varying degrees, and members of a third group may fall in various positions within the body of the diagram determined by the subject mix involved. These course representations are all based on existing courses at U.K. universities, further areas of the diagram may be occupied by other courses. If each course shown satisfies the three criteria given above then it can legitimately be looked upon as an environmental science/studies course in spite of its dissimilarities in content from others shown.

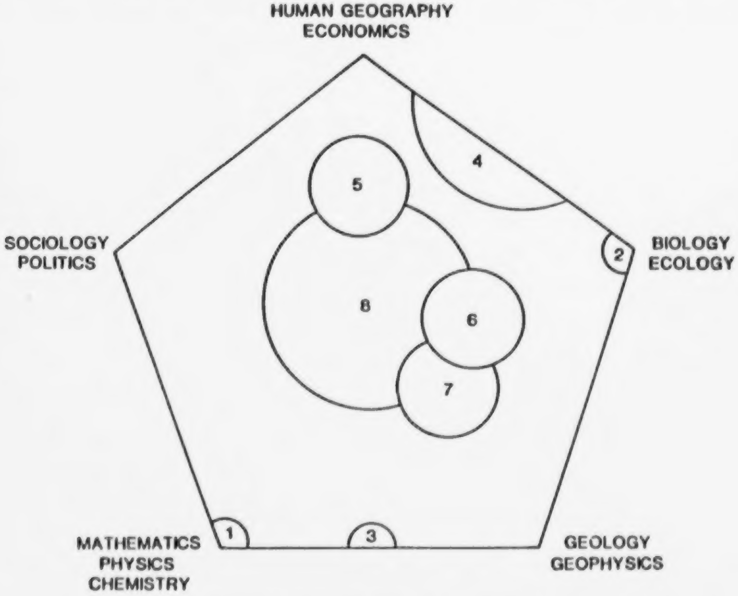


Fig. 1. Schematic representation of the relationships between course content and the "total field" of environmental sciences/studies subject material.

Although the courses represented by the areas on Figure 1 all qualify as valid environmental courses they all suffer from two disadvantages when considered as "ideal" environmental science/studies courses. One is the inevitable shortcomings which results from the practical problems of subject selection, leaving wide areas of relevant subject material unconsidered. This shortcoming must be largely accepted, for reasons already discussed, but can be partially rectified. The second shortcoming arises because few courses fully meet the requirement that they should be aiming at the production of graduates professionally able to contribute to the management of the man/environment interaction. This deficiency may be intentional, when there is no desire to include a "professional" component in the course, or unintentional, as when the omission is recognised but no mechanism can be evisaged for rectifying it. Both situations can arise. The first may be justified by pleading that "professional" considerations are incompatible with the main thrust of the course, will dilute its overall impact and, in addition, do not have the required intellectual merits. This view may be genuine or only a rationalisation avoiding the need to find a solution. This outlook cannot be acceptable in principle as environmental education has specific merits only when it is professionally oriented. Additionally the outlook is invalid academically as the intellectual problems of solving real problems using "environmental" information are considerably more demanding and stimulating than those experienced when dealing with "eternal truths". The only valid justification for failing to provide a professional element in an environmental course is that of uncertainty about how it can be done.

DESIGN OF LINK COURSES

The professional elements in environmental education can be introduced by "Link" courses. These relate the specialised components of the main courses to their applications, and the procedures and practices involved, in real situations. The "Link" courses will also draw in contributions from other subject areas, such as Civil engineering, economics, politics, law and planning, so that they will provide a partial bridge between the selected main course content and the total subject matter of environmental science/studies. Suitably constructed "Link" courses may thus play important roles in filling gaps which will otherwise exist in environmental courses. Each "Link" course will have to be specially designed in relation to the content of its parent course, the staff available and their abilities. Courses will thus be highly specific in their content and structure, although each will be entirely valid as a vehicle for introducing professional elements into undergraduate training, and no generally valid statements can be made about their construction. As a guide to course development the "Link" course at Lancaster will be described and used as a basis for discussing the underlying philosophy involved, the problems which may be experienced, and possible solutions.

The "Link" course taught within the Department of Environmental Science at the University of Lancaster is entitled "Environmental Management". It is an option within the Environmental Science B.Sc. major course, but is available to students from other departments as well, Since the course started in 1980/1981 it has been taken by over 100 students. The course contributes one-ninth of the overall assessment in the Final Degree. It involves about 80 contact hours during the Autumn and Spring Terms, although this year it has been taught in a reduced form of 50 contact hours as an initial step to transferring it to the Third Year. I teach all the lectures and practicals, with assistance from visiting speakers.

The objectives of the course are:-

a) to indicate the range of specialisations and professions likely to be involved in "environmental" projects,

b) to provide an understanding and appreciation of their differing contributions to a project, and the role played by the environmental scientist,

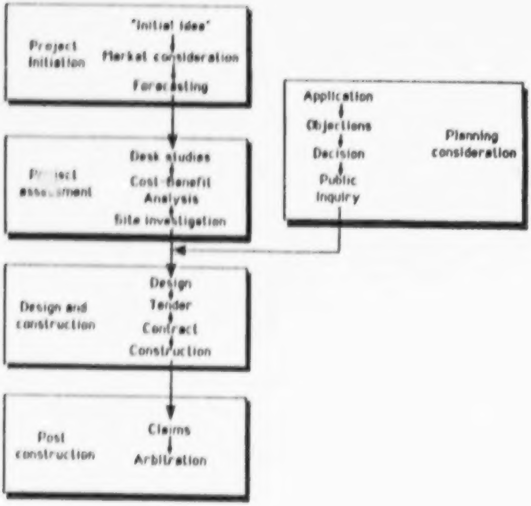
c) to introduce the range of documentation likely to be used in a project, and to provide direct experience in its use,

d) to demonstrate the practical problems resulting from limitations in time and money, and show that a "research" approach is seldom possible.

The course cannot hope to provide complete coverage of these topics, as almost all treatments are brief. Instead the emphasis is on generating an awareness of the range of factors involved in environmental employment, their interrelationships, the problems which may be encountered, and methods available for their solution. Graduates who have taken this course have reported very favourably on the benefits they have gained from it when entering their first jobs. This provides a reasonable justification for concluding that the course is succeeding in its declared aims.

The structure of the course is based on the normal sequence of events involved in the development of a project from an initial idea to completion (Figure 2). The two threads, practical and legal, have been separated for convenience and taught in the two terms with their interrelationships being provided by case studies and practical work.

Lectures in the Autumn Term start with a detailed discussion of the Cow Green Reservoir project and the associated controversy. This includes all the elements given in Figure 2, relating them together in a real context, and provides a logical framework within which later more detailed lectures can be placed. Later lectures fall into four groups: Project Initiation, Project Assessment, Design and Construction, Post-Construction.



'Initial idea'
Project initiation
Market consideration
Forecasting
Application
Objections
Decision
Public inquiry
Planning consideration
Desk studies
Project assessment
Cost-Benefit Analysis
Site investigation
Design
Design and construction
Tender
Contract
Construction
Post construction
Claims
Arbitration

Fig. 2. Simplified summary of the sequence of events in project development.

Project Initiation is discussed in terms of the forecasting of demands and resources, the prediction of shortfall, lag time and the economic considerations involved. Examples are drawn from the forecasting of water and aggregate demands, and traffic flows. The main forecasting procedures are reviewed (historical time series, aggregated and dis-aggregated variables, empirical and theoretical relationships, surveys) and assessed critically. Resource estimation in earth science is contrasted with simple market economy concepts. The possibilities of "discovering" added reserves by altering social and industrial aspirations and practice are discussed. These lectures introduce forecasting as an essential element in planning but counsel caution in the over-enthusiastic use of the results.

Project assessment is considered in three small units of Desk Studies. Cost-Benefit Analysis and Site Investigation. Desk

Studies for real projects are used to indicate the range of factors considered, their collation and analysis, and roles in determining the eventual short-list of sites and lists of more detailed information required. Details discussed include simple cost analyses, the use of the sieve technique, market prediction and transport, extraction and reclamation problems.

Cost-Benefit Analysis is treated sceptically as a technique which has many attractions to decision-makers, and is therefore here to stay, but which has many problems when applied to the environment. Introduction to the philosophical and practical bases of the method are followed by considerations of the problems inherent in establishing monetary values for beauty, amenity, time and life, among others, the problems of present-costs and future benefits, Net Present Values and assumed Discount Rates. The more "realistic" attractions of the Willingness to Pay approach are discussed. The aim of the lectures is to provide familiarity with economic concepts and an introduction to their practical limitations so that a realistic assessment of their usefulness can be made.

Site Investigation is considered in the broadest terms and draws on other lecture courses. Three aspects are emphasised:-

a) the need for a thorough evaluation of all available data before proceeding to more detailed investigations,

b) the interrelationships between the results of a), the overall project, and the design and performance of the detailed investigation and,

c) the implications of clauses 11 and 12 of the Institution of Civil Engineers Conditions of Contract.

Case Studies are used to illustrate different types of site investigation, site investigation procedures, data selection and logging, and the contractual problems.

The third group of lectures is devoted to the Design and Construction stages. The general principles of design are discussed in terms of achieving performance requirements, satisfying statutory and other obligations, and incorporating the results of site investigations. British Standards, Specifications, Codes of Practice and other design "aids" are introduced. The design process is illustrated using an example of a Plynlimon Flume designed and constructed as part of a research contract. This is followed by consideration of the Tendering process, using the same example, introducing the Standard Method of Measurement, Bill of Quantities and Tender Documents, and the terms and significance of the Institution of Civil Engineers Conditions of Contract.

Construction is not considered explicitly, largely because of limitations of time, but some aspects are introduced in other lectures and on site visits. This part of the course may be expanded at a later stage.

The final lectures in the Autumn Term deal with post-construction claims and arbitration. Types of, and grounds for, claims, procedural requirements and the basis of arbitration are outlined briefly. Most of the lectures are devoted to a detailed case history with emphasis on the relationships between claims and site investigation, the problems of predicting expected conditions, and the concepts of the "experienced contractor" and "reasonable foresight". The progression from initial claim to arbitration is illustrated and discussed.

Lectures in the Spring Term are devoted to the planning thread shown in Figure 2. Town and Country Planning and Public Inquiries occupy the bulk of the lectures but brief introductions to the principles of general and environmental law are given to set them in context. Initial lectures discuss the nature of law, the origins of English Law, legislation and the legislative process. Statutes, Statutory Instruments, Private Bills and Circulars are studied to provide an introduction to legal sources. Environmental law is related to both Statute and Case Law, with particular attention to the torts of nuisance and negligence, and their implications for professional practice in the environmental sciences.

Town and Country Planning law is presented as the portion of our legal system most likely to affect all graduates at some time, as experts for industry, local government or objectors, or as intelligent laymen. The background to modern planning is sketched and followed by detailed consideration of Planning Policy, Structure and Local Plans, Development Control, and Planning Procedure. These aspects are illustrated with documents and case histories. Public Inquiries are discussed in detail in three stages. First the basic fabric of Inquiries (origins, aims, legal basis and procedures) is described. This is followed by several case studies, which illustrate the operation of the system both in general and more specifically in relation to scientific matters. Finally the problems of preparing for, giving evidence, and being cross examined at, a Public Inquiry are considered in detail. These lectures lead on to a discussion of the different roles which witnesses may have to play and their implications for scientific, professional and personal ethics and integrity.

The lecture courses in both terms are supported by practical, seminar and tutorial classes. These are all based on real problems and provide practice in basic skills, data analysis and evaluation, critical combination of environmental and other data inputs, and juggling with the conflicting demands of industry, local authorities and conservation. Visiting speakers in seminars, and contact with local specialists during project work further extend the reality of the course. Practicals have been based on two projects in which I have been involved as a consultant. These are the Lune Estuary

Aggregate Study and the Coolscar Quarry Public Inquiry. Both are still "live", and local, so that student involvement has been very satisfactory. In general, the first term has been concerned with collation and analysis of basic data, giving the "commercial viewpoint", and the second term has then considered environmental and conservation aspects. In the second half of the second term each proposal has been considered in a Mock Public Inquiry. In this all students have been given roles as witnesses or advocates. These roles, and Proofs of Evidence, have been developed using lecture material, previous practical work and discussions with the appropriate "real people" in Lancaster.

The Public Inquiries have lasted for two afternoons, and have been highly successful. Tutorials have been used to discuss newspaper reports of current proposals, and possible responses to the local authority, or to overcome problems encountered in lectures. Site visits have been arranged when appropriate.

The planning and establishment of a "Link" course similar to that just outlined will be accompanied by many problems. Many have already been encountered in my own course and various solutions attempted. These provide some guidelines for others contemplating this type of venture. Student response to the course has been monitored each year using a standardised questionnaire so that my conclusions are a combination of personal and "consumer" responses.

The first, and most difficult, set of problems to be encountered during planning is in the area of academic acceptability. Colleagues may believe that this type of course is not academically respectable and that it is providing a convenient lay-by for the less scientifically-able students. Questions of diffuseness in the material taught and of intellectual lightness may also be raised. These fears should be dismissed as misplaced not only on basic academic grounds but also on the basis of student's responses. These indicate that the course was found to be demanding in terms of both load and intellectual demands, as well as being stimulating, useful and rewarding. Initial responses to proposals to establish Link-type courses will probably differ widely from department to department. I have found enthusiastic support for my ideas in "applied" departments, engineering and management, and in the social sciences, but little or none in the pure sciences or humanities.

If the principle of establishing a Link course is accepted the next group of problems to be encountered will be concerned with its status, course length, structure, timetabling and staffing. These are interrelated to varying degrees. New courses, especially those viewed with any degree of suspicion, can be introduced most readily as options. This permits student choice and allows those wishing to consolidate their academic basis to avoid it. Course length will be determined by an interplay between the optimum option size and staff availability. My experience has shown that the 80 contact hours format was preferred, by staff and students, to the shorter form of course. This course length gave sufficient time to develop the topics, and their relationships through the lecture-practical interaction which the shorter course did not permit. Spreading the course over two terms was also preferred as this gave time for reading and project work to be spread out and allowed ideas to mature. Staffing may be the factor determining whether this type of course can be initiated. I believe that the course should be taught by one person. This will maintain continuity, enable the balance and detailed content to be adapted to student response, and assist in achieving its "evangelical" role as students may be lead to believe that at least one staff member has the breadth of interest advocated by the overall course concept, but not supported by the usually highly-specialised staff! Visiting speakers, playing very specific roles within the course structure, can provide valuable inputs but any attempt to share the course equally between several staff each teaching aspects of their own specialisation must inevitably introduce problems of credibility and be counter-productive. The staff member in charge must clearly be a volunteer, as must any other staff involved, as the course is essentially evangelical and enthusiasm and conviction must show through at all times. The staff involved must also have detailed experience of the realities of applying environmental science, bringing them into contact with the full range of aspects and not just the use of their own specialism. This requirement may immediately preclude any chances of developing this type of course as few staff will have had the chance to become deeply involved in the practice of environmental science over an extended period. Instead of dismissing the possibility of course development because of shortage of expertise it will, however, be preferable to develop a course and outside interests in parallel, accepting that in its initial years the course may be only second-best.

In a well constructed environmental course separate elements will be interrelated to provide the essential integration and balance required. Under these circumstances it will be natural to expect that a Link course will similarly fit into the overall pattern and draw on material presented in other courses. As well as maintaining the general course philosophy this relationship will also produce an important integrating effect in its own right. Although this may be optimal, the decision on whether to integrate a Link course into the general structure or teach it as a separate unit has important implications for the complexities of course preparation, course independence and flexibility, and course timing. In the initial stages of a new Link course it is probably realistic to teach it as a free-standing course. This allows maximum flexibility in course content and timetabling, has no implications for the teaching of other courses, and allows the course to be placed anywhere in the degree structure. The Environmental Management course draws on First Year course elements and general knowledge only. This retains a relative simplicity in the environmental science involved and enables me to concentrate on the principles and details of other new subjects without encumbering students with new scientific problems as well. This independent basis also makes it possible to teach the course in the second year, providing insight and stimulation for later courses. Valid arguments can also be advanced for placing the course in the Third Year, as we are now proposing.

The final set of problems encountered is in the provision of suitable materials to support case-study based project work, and the selection of appropriate reading matter. Case study materials can probably be obtained via suitable contacts, although here again personal involvement in consultancy will provide great benefits. Raw data are essential within the conception of my course, to provide real insight into practical problems, but they must also be "improved" to prevent students taking excessive time over mundane tasks. This requires considerable preparatory work. Literature is also a problem as there are not texts suitable in their entirety, and useful papers are scattered through many journals. The basic problems of collecting appropriate literature have now been exacerbated by the effects of the Copyright Laws on photocopying. There is no easy solution to the literature problem except extensive annotated reading lists, and a sympathetic library system, unless a specially commissioned text appears.

The plethora of problems identified as likely to be involved in the planning and implementation of a Link course may be taken as a justification for dismissing all ideas of pursuing such a development. This response will be over-pessimistic as the number of problems actually partly reflects the wide flexibility which is possible within this type of course, and its adaptability to virtually any circumstances. I would encourage anyone contemplating this type of course as I have found it a very stimulating and rewarding form of teaching with job-satisfaction far outweighing the initial teething troubles. I hope that this paper will encourage staff in other departments, and other types of courses, to investigate the benefits and provision of Link courses.

TEACHING ENVIRONMENTAL SCIENCE WITHIN A A MODULAR DEGREE SCHEME

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INTRODUCTION

A pan-Faculty of Applied Science modular scheme of B.Sc. Degree Courses in Sciences has operated at Coventry (Lanchester) Polytechnic for 10 years. This scheme permits students to take Applied Biology or Geography Degrees, with an ecological or environmental bias, a flexible variety of Combined Science Degrees which can include environmental chemistry or environmental economics, and since 1980 a named Degree in Environmental Science also. The 10 year period has seen a steady and continuing recruitment of students with some form of environmental interest, a trend correlating with that for British universities as elucidated by Cousen and O'Sullivan (1984). It has also been frequently observed that students, who unquestionably have an environmental commitment, are nevertheless, on admission, uncertain precisely what academic curriculum will best match their perceived interests and career aspirations. Accordingly, many have taken full advantage of the flexibility of the modular scheme to marginally adjust or more radically change course at the end of the first year. These observations are again comparable to those made for universities by Moffat (1985). The modular scheme, therefore, has the distinct advantage of flexibility and permitting year-on-year "fine tuning" of course content in response to student demand and availability of resources. This goes some way to alleviating the problem of those 18-year-old students who, on admission, are too inexperienced to make an irrevocable choice of what Degree course to follow.

However, modular schemes suffer the disadvantage that teaching comes in quantum chunks of essentially inflexible magnitude. Further, a student pursuing an unusual module combination (albeit academically impeccable) may feel his course options lack coherence, together with the social factor of continually meeting a different set of class companions. The problems for course design and operation thus posed require value judgements. They are by no means unique to a modular Environmental Science course, but in view of its necessarily multidisciplinary nature may be therein experienced more acutely. This paper considers some of these problems and comments on attempts at solutions currently being pursued at Coventry.

BREADTH AND DEPTH IN ENVIRONMENTAL SCIENCE

There have long been wide differences in perceiving just what is meant by "environmental science" by individuals with disparate specialist backgrounds, be they heating engineers, ecologists or sociologists. Initial attempts at multidisciplinary synthesis met accusations of its being undefined and superficial; such is the degree of blinkered thinking in traditional disciplines that these accusations continue (Ager, 1985). One particularly regrettable consequence of cuts in education funding in the 1980's has been a withdrawal into the trenches of traditional disciplines by those who believe that environmentalism is a luxury that can be afforded in times of plenty but is indispensable in times of scarcity. However, steady progress through the 1970's in cross-disciplinary understanding has produced a consensus definition of what constitutes the coherent subject matter of environmental science. This has been clearly set out by Potter (1985). The problem remains, however, that an attempt within a 3-year Degree coruse to include study of all the component topics of environmental science would necessarily produce superficiality. It is necessary therefore for a given course to define a precise target as its focal core, whilst permitting exploration of wider related issues by choice from a range of options. The course at Coventry thus defined its aim as being to provide an understanding of the physical and biotic processes of the natural environment and the application of this in the management, monitoring, and control of renewable natural resources - these being essentially biological and water resources. Thus the concepts of ecology and conservation lie at the heart of the course. Its teaching is drawn from the Departments of Geography, Biology, Chemistry and Statistics and Operational Research. The outline curriculum is shown in Table 1. The concepts and methodology of the course are firmly based in the natural rather than the social sciences. This is not, however, to detract from the social relevance of the subject matter. The combination of core modules ensures a major emphasis on practical work in both the laboratory and the field, including four one-week residential field courses.

It is a matter of judgement how much course material should be obligatory core and how much choice of options should be allowed. The Coventry scheme (Table 1) provides for 60% of time spent on core material and 40% on optional and independent work. Experience has shown this to be a functionally effective balance. It enables students with, say, an interest in pollution monitoring and control to acquire practical training in chemical and biochemical analytical techniques. Alternatively, an interest in nature conservation can be reinforced by study of biogeography, soil science and the ecophysiology of plants and animals.

Not everything has been an organisational success. The debit side of the modular system is seen in the regrettable omission of economics and geology from the course, where administrative and logistic constraints has produced casualties of what on academic grounds would

TABLE 1

Outline Curriculum of B.Sc. Degree and Honours Degree in Environmental Science at Coventry (Lanchester) Polytechnic (1985 Revision)

Part 1 BIOLOGY
GEOGRAPHY
CHEMISTRY
PRACTICAL DATA PROCESSING 1 (Statistics with Computing)
Ancillary Mathematics

Part 2 Core : RESOURCE MANAGEMENT I
ECOLOGY
PRACTICAL DATA PROCESSING II

Options From : BIOGEOGRAPHY AND SOILS I
GEOMORPHOLOGY I
CLIMATOLOGY
ANIMAL AND PLANT PHYSIOLOGY
ANALYTICAL CHEMISTRY
BASIC BIOCHEMISTRY

Sandwich Year of Professional Training (Optional)

Part 3 Core : INDEPENDENT PROJECT or DISSERTATION
ECOLOGY AND CONSERVATION
RESOURCE MANAGEMENT II

Options From : PRODUCTION AND POLLUTION ECOLOGY
CROP PROTECTION
ENVIRONMENTAL TOXICOLOGY
BIOGEOGRAPHY AND SOILS II
APPLIED HYDROLOGY
GEOMORPHOLOGY II
QUATERNARY STUDIES

be desirable. Potter (1985) has drawn attention to the lack of economics teaching from many environmental science courses and hearty concurrence is expressed with his view that an understanding of economics is of important significance for the whole of environmental study - not just its social science aspects. In practice some amelioration of this omission has been effected by holding joint seminars with the Environmental Economics module to which environmental science students contribute constructively.

Similarly a foundation study of geology would be desirable as giving the basis for a consideration of environmental issues relating to the exploitation of mineral (i.e. non-renewable, some partially recycleable) as well as renewable resources. There are possibilities for some improvements in future years, in these respects, with the evolutionary development of the whole modular scheme, but these cannot be forecast with certainty.

INTEGRATION WITHIN ENVIRONMENTAL SCIENCE

It is frequently believed that multidisciplinary and modular courses are the ones most susceptible to a lack of integration and an absence of making explicit the cross-relevances amongst various parts of the subject matter in the demonstrable teaching arrangements. Experience suggests that in practice this problem is no more acute than it is for custom-built courses in traditional single subjects. One of the most extreme forms of modular system is that operated by the Open University; although this makes named Degrees unavailable to its B.A. graduates, it has not prevented the O.U. from steadily gaining recognition of its Degrees as postgraduate prerequisites and by professional institutes. What cannot be minimised however is the problem posed by the chronic tendency of many students to bone up on material delivered by one lecturer in isolation from that by others, and then regurgitate it in examinations in compartmentalised form. There is no magic solution to this problem and integration is not conspicuously improved by erecting administrative structures designed to force its occurrence in a manner demonstrable to (for example) external validating bodies. Rather it is a matter where there is no substitute for sensitive informal discussion in individual or small group tutorials - facilities which the progressively more sombre staff resources situation is making it increasingly difficult to provide. In fact and in practice, integration in the thinking of the student of disparate strands of knowledge occurs most successfully in informal serendipitous "seminars" which spontaneously erupt on (for example) residential field courses, working weekends of the Conservation Corps, or late night social gatherings. The key therefore may be a readiness of staff to be less concerned with formal administration and more ready to participate flexibly in extra-curricular activities.

An important integrating component of the Coventry course is independent project or dissertation work carrying 20% of assessment in the final year. Students are permitted, indeed encouraged, to develop their own ideas for the topic of their project under the supervision of staff from any of the contributing Departments. However, the final decision on the nature of the project requires the agreement of the Course Tutor, and this is granted only for topics which require the student to draw upon knowledge and skills from across the spectrum of taught modules.

VOCATIONAL NATURE OF ENVIRONMENTAL STUDIES

Few issues cause more heated debate amongst academics than the necessity or otherwise of making first Degree courses a training in technical skills with specific employment outlets. Attitudes range from those who consider a vocational course to be "teaching monkeys to perform tricks", to those who castigate anything non-vocational as a "fun" Degree. To be more constructive, traditional higher education in Britain has been rightly criticised for being over-populated with ivory-towered academics who are too slow to apply their undoubted abilities to the problems of society at large. On the other hand there is validity in the contention that education at first Degree level should concentrate on cultivation of general intellectual skills which can then have application in a range of careers in industry, science or administration. Perhaps more than any other discipline, environmental science courses need to seek a balance between these polarised attitudes, although this can result in their receiving flack from both sides. Certainly an environmental science course at any level must deal with issues of direct relevance to society: the processes of food and energy production, resources exploitation, pollution and their environmental consequences; there is little justification for anything less. Further, in the development of thinking about the Degree course at Coventry, a highly practical bias recommended itself. The intention is thus that students of environmental science should not be those who sit and wring their hands complaining "The environment is deteriorating; Oh Doom!", but should rather be those who acquire the technical skill as well as the intellectual commitment to take effective action to improve the quality of the environment. From these considerations sprang the decision that environmental science students should all take at least a foundation study of Chemistry as well as of the life and earth sciences. To this extent then, the Coventry course is clearly vocational. Its graduate first employments have been amongst precisely those intended: nature conservation management, local authority urban ecologist, agrochemical industry, water authorities, work on an organic farm cooperative, P.G.C.E. with environmental studies main subject.

At the same time, because environmental science necessarily leads to numerous small outlets rather than a few big ones, it is essential that the environmental scientist retains a substantial measure of intellectual flexibility, and too much emphasis on narrow technical training needs to be avoided. Also, putting the education system in a global context, there is no particular reason to suppose that the first Degree graduate at the tender age of 21 years is already a fully qualified professional. It is perfectly rational to suggest that an environmental science Degree lays the foundation on which post-graduate specifically vocational training can build; this may take the form of M.Sc. courses or study for professional institute membership examinations.

A further consideration is that it is intellectually dishonest for the environmental science educator to concentrate *exclusively* on the production of graduate-fodder for the job market just as it is. Whilst the environmental scientist will normally wish, even feel obliged, to render useful service to society, this should not imply a blind subservience to the prevailing economic order. An essential aim of higher education always must be the cultivation of a facility of critical appraisal and analysis of natural and social phenomena. Thus a society, which lucratively rewards its lawyers and accountants but leaves wildlife conservation (apart from the understaffed overstretched N.C.C.) in the hands of volunteers and M.S.C. teams on breadline wages, cannot expect unqualified approval from environmentalists. Environmental education is thus likely to engender a measure of consciousness raising and politically radical commitment. Without necessarily becoming a "hippy ecofreak", the environmental science student will frequently be concerned to question popular attitudes and accepted beliefs about the environment. An environmentalist is essentially a conservationist who will therefore, experience a wish to reform the profligate and polluting abuse of the environment by modern society. Environmental education therefore has, apart from subject-specific aims, the twin objectives of both serving and criticising the society within which it occurs. The means of achieving the two without conflict is to teach the objective treatment of subject matter by the application of the scientific method and to beware of any idolatory of any particular political doctrine. An important element of environmental science teaching is the methodology of rigorous data acquisition (whether by laboratory experiment or field survey) and of statistical analysis. The concepts of experimental design and data analysis are essential for all students, but an understanding in depth and a thorough practical familiarity is especially important for environmental scientists; accordingly the Coventry course makes modules in Practical Data processing obligatory for all students in both First and Second years.

CONCLUSION

There is no one simple formula for designing and running a successful first Degree course in Environmental Science. Progress is continually beset by problems, the nature and magnitude of which depend on the logistic, administrative and academic context in which it is pursued. None of them is insuperable however, given imagination and a readiness of staff from disparate backgrounds in traditional disciplines to seek sympathetic mutual understanding. Experience suggests that *on balance* the advantages of a modular system outweigh the disadvantages in its providing a rapid and flexible course modification facility in response to external pressures. Integration of multi-disciplinary subject matter can be achieved by careful student counselling and independent work. An environmentalist commitment combined with rigorous training in the scientific method can equip the student both to usefully serve the society in which he lives and to improve the quality of its environment.

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INCLUSION OF ENVIRONMENTAL HEALTH STUDIES IN THE VETERINARY MEDICAL PROGRAMME IN NIGERIA

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INTRODUCTION

It is not definite when veterinary practice started in Nigeria. "The presence of a species of tsetse fly which conveys the trypanosoma bacillus has been demonstrated at Zaria by the research of Veterinary Captain Carr" (Marshall, R.S.).

As far as can be ascertained, this statement seemed to be the first reference to veterinary practice in Nigeria, reported in the Royal Army Veterinary Corps records for 1904. The following year, 1905, Captain Carr was again quoted as planning a donkey production scheme for army veterinarians who were being seconded from the Royal Army Veterinary Corps to Nigeria for Veterinary services. Apparently, there seemed to be nothing in record again from 1905 to 1913 when it was decided officially that veterinary departments be established as a result of representations made by the German Government in Cameroons to the Nigerian Government with particular reference to international movement of livestock and the widespread existence of rinderpest following the earlier pandemic of the plague. (Veterinary Council of Nigeria, 1985).

In 1914, the Veterinary Department was established with headquarters in Zaria initially. This eventually moved to Vom in Plateau State and remained so until 1954 when a new constitution came into existence. The functions of this department in the early twenties was mainly devoted to the control of diseases because of the wide spread epizootic and enzootic diseases which had been responsible for enormous losses in the livestock population. The disease control policy for that period and for many years after the inception of the Veterinary Department was mainly mass vaccination annually against livestock plagues such as rinderpest, contagious bovine pleuropneumonia (C.B.P.P), anthrax, blackquater, and haemorrhagic septicaemia. The intra and international movements of trade cattle were brought under control. Another function of the Department was the improvement of hides and skins, a valuable foreign exchange earner for the government.

Nigeria, an agricultural country, has a vast livestock population as well as a large arable farming land. Pre-independence, she relied essentially on the export of agricultrual products for foreign exchange. About a decade after independence, petroleum gradually took greater importance, hence relegating the country to that of an importer of basic foods items as agriculture suffered a big blow.

Happily, greater effort is now being directed to reviving agriculture to its rightful position - one of such efforts is the importation of chemical fertilizers for use by farmers. The Government has also made a substantial investment in a chemical fertilizer making industry to supplement imported ones.

Other inputs in the agricultural sector include the production on a large scale, as well as importation, of pesticides and herbicides for use by farmers.

The 'oil boom' that Nigeria experienced in the early seventies also brought along in its make, substantial revenue for very rapid technological development leading to dam constructions, and the establishment of many industries producing items such as batteries, foam, alcohol (breweries) textiles, petrol, kerosine etc..

All these technological developments have however brought along various environmental problems associated with the discharge of their effluents without treatment into streams, ponds, rivers and even on land surfaces.

With an increasing awareness of the dangers posed by the consumption of unwholesome meat, the Government has set up numerous abattoirs in major cities. Again, these establishments have been known to discharge their effluents into nearby streams or land surfaces.

A major source of protein in the Nigerian diet is fish and shellfish, especially amongst the communities along the coast and those with major rivers and streams. The practice by a number of unscrupulous fishermen eager to make quick money by the use of toxic chemicals for such catches has placed the health of such fish and shellfish consumers in danger of food poisoning.

In the light of these various environmental pollution problems, the inclusion and emphasis in a Veterinary curriculum of environmental health studies in Nigeria becomes highly justified.

VETERINARY EDUCATION IN NIGERIA

A recommendation of the FAO/WHO Expert Panel on Veterinary Education held in London in March, 1962 (FAO/WHO, 1962) suggested that two veterinary faculties be started in Nigeria; one at the University of Ibadan (in the west) and the other at Ahmadu Bello University (ABU) Zaria in the North. The two faculties were to share efforts in producing veterinarians where Ibadan will teach the preclinical courses while A.B.U. was to offer training in clinical subjects because of abundant animal resources in the northern parts of the country. The first veterinarian to be trained in Nigeria graduated in June 1967. Hiterto, any Nigerian who wished to become a veterinarian trained overseas. Presently, there are four fully fledged faculties of Veterinary Medicine in Nigeria located at Ibadan, Zaria, University of Nigeria,Nsukka in the East, turning out an average of 150 veterinarians except Maiduguri yet to graduate a veterinarian.

RESPONSIBILITIES OF VETERINARIANS IN NIGERIA

The need and demand for competent veterinary services has generated demand for more trained veterinarians.

Although well over 90 per cent of registered veterinarians in the country are in one form of government service or another, current trends in our industrial and agricultural developments indicate an increasing move towards private veterinary practice.

With the ever-increasing number of veterinarians, and the improvement in the services rendered, the livestock disease picture is changing from that of the major plagues, such as foot and mouth disease, rinderpest, contagious bovine pleuropneumonia, anthrax and pasteurellosis, to insidious diseases and nutritional problems. The profession therefore has a wonderful opportunity of rendering valuable public services not only in animal health care delivery but also in animal production and in human health care through participation in public health and preventive medicine.

It is in the light of the tremendous challenges and opportunities ahead that the veterinary curriculum in Nigeria and that in Ahmadu Bello University, Zaria in particular, has regularly undergone reviews.

ENVIRONMENTAL HEALTH COURSES TAUGHT AT THE DEPARTMENT OF VETERINARY PUBLIC AND PREVENTIVE MEDICINE, A.B.U., ZARIA, NIGERIA

A. Ecology: Review of basic ecological terminologies; ecological approaches and resultant health problems arising from various technological developments e.g. effect of dam construction on snail population and as this relates to certain diseases of livestock infected with snailborne parasites - e.g. schistosomiasis.

B. Community and Environmental Health:

(a) The current concept, scope, goal and priorities of public health and its contribution to human health and national development. This aspect touches on water pollution from various sources including industrial discharges, pollution from petrochemical set-ups; sewage disposal as these relate to contaminating grazing pasture for livestock; water pollution as it relates to fish and shellfish hygiene; disposal of abattoir waste products.

(b) Effect of the indiscriminate usage of chemical fertilizers, pesticides, herbicides etc. on livestock, feeding on pasture contaminated by these toxic chemicals and also on humans feeding on the animals.

(c) Field visits to various establishments and industries to learn at first hand the nature of their waste products and methods of disposal or treatment.

These courses are taught in the 4th year of this five year programme when the students have undertaken toxicology, physiology, animal nutrition, and parasitology amongst others. The students are then in a better position to readily assimilate the subject matter and the underlying principles of environmental studies.

CONCLUSION

Several incidents in fluorosis in cattle have been reported in Stoke-on-Trent, England and this has been attributed to the excessive ingestion of vegetation from pasture contaminated by industrial emissions (Bennet and Barrat, 1980), while the problems of water pollution have been accentuated by the speed of growth of the population and of industries as well as by changing technologies and new agricultural practices (Cluke, 1982). In Nigeria, water pollutants have resulted from the uncontrolled disposal of sewage and other liquid wastes resulting from domestic uses of water, sediments from land erosion, minerals and chemicals from industrial wastes, insecticides, pesticides, detergents, radioactive substances and heat from power and industrial plants.

The need for adequate control measures to guide against environmental pollution resulting from industries and agricultural practices and the stepping up of a mass education of the general public, especially the livestock owners, on the dangers of these pollutants is highly desirable.

The inclusion and study of environmental health, especially as it relates to animal health and production, on the Nigerian situation, therefore, will go a long way to ensuring that a Nigerian trained veterinarian lives up to the challenges of the profession as "he can not ask his patients what is the matter, rather, he's just got to know".

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UNIFYING EDUCATION WITH ENVIRONMENT SYSTEMS OVERVIEW#

H. T. Odum

University of Florida*, USA

As humankind increasingly controls the planet, its citizens will need a commonsense overview to plan their existence. Fortunately, the public is already learning to think globally with the help of international television, satellite views of the weather, and programs on world macroeconomics. Now our educational systems need a curriculum to help.

Whereas small scale things have fast turnover times, large scale phenomena have long time periods for their cycles of replacement. Because we are part of a large interdependent system of humanity and nature, much of what is most important happens on the longer time and larger scale of the environmental system. Human lives are most affected by the patterns and cycles involving months, years and decades. These depend on phenomena on the scale of the landscape and larger.

Much of our education omits the large scale environmental-economic systems. Where science education has emphasized only the small realms of chemistry, physics and small scale biology, people are left without means to understand the landscape, the nations, and the globe. We now need science and public affairs education to help understand the larger scale phenomena as well as the smaller parts and mechanisms.

However, education about large systems has been slow. Many think the realms of the human economy and nature have no deterministic principles and can be whatever humans want. With roots in humanism, economic theories consider human preferences as the main cause. Consequently, marketplace costs are often regarded as measures of value to society.

Perhaps this conference on environmental education is part of the movement to give our educational programs a unified overview of the systems of humanity and nature which is intellectually rigorous. There have been calls for new ways to organize of often-fragmented environmental science teachings.

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# A keynote lecture at the Third International Conference on the Nature and Teaching of Environmental Studies and Sciences in Higher Education, September 8-12, 1985.

In this presentation is proposed an energy systems methodology for teaching environmental science, for unifying environmental studies and economics, for facilitating modelling and simulation, and for selecting alternatives that maximize economic vitality.

ROLE OF ENERGY SYSTEMS DIAGRAMS

The diagramming of systems of environment and economics is facilitated by diagrams with energy symbol language. The language is simple, international, precise, synthetic, quantitative and simultaneously holistic while also representing analytical detail. The diagramming rules provide for economic relationships, environmental science relationships and coupling of the two. These energy symbol diagrams are used in this article to help explanations. Some of the main symbols are given in Figure 1. References at the back contain explanations of the symbols and their use (Odum, 1970, 1983; Odum and Odum, 1982).

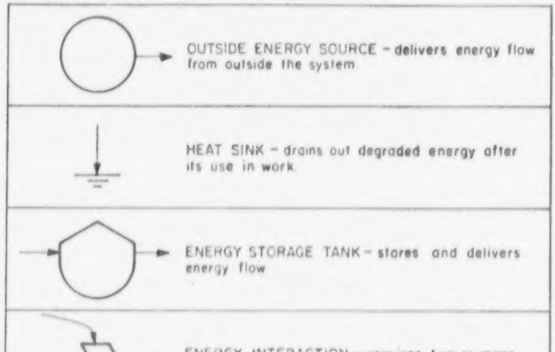

OUTSIDE ENERGY SOURCE – delivers energy flow from outside the system.
HEAT SINK – drains out degraded energy after its use in work.
ENERGY STORAGE TANK – stores and delivers energy flow
ENERGY INTERACTION – requires two or more kinds of energy to produce high quality energy flow.
ENERGY-MONEY TRANSACTION – money flows in exchange for energy.
GENERAL PURPOSE BOX – for any sub-unit needed, is labeled to indicate use.
PRODUCER UNIT – converts and concentrates solar energy, self maintaining; details may be shown inside.
CONSUMER UNIT – uses high quality energy, self maintaining; details may be shown inside.

Figure 1. Energy language symbols

To achieve the overview perspective now needed for understanding environmental systems and their contained economies, the systems should be diagrammed at one size level larger than the particular questions and mechanisms under consideration. This is because the major changes in any systems tend to come from the controlling actions of larger systems interacting with small components in amplifier actions.

An example in Figure 2 is the energy systems diagram of Ireland in the 19th century at the time of the great potato blight famine. The diagram shows the interplay of two years of diminished sun in rainy summers causing potato blight and starvation because of an overpopulation that had followed medical improvements and development of a monoculture type of economy. Without much summer sun there were also shortages in sun-dried peat-fuel, hay and livestock products. Most trees had been cut in the previous century for export to England. With cash crop failures, rural people and commerce in towns were destitute. Lands were lost in foreclosures and rent defaults. Planting was disrupted and the second year blight was worse than the first.

Epidemic disease developed with nearly a million deaths and emigration of three million people (Moody and Martin, 1984; Mitchell, 1976). The symbol network shows both the mechanism of interactions and the general pattern of rural production and consumption. Political and economic control by England is shown without any systems mechanisms to regulate carrying capacity or cushion the emergency. These were times of laissez faire policies. Could the outcome have been any different if political influences of the time had had a systems overview?

The symbol language can be used to help people of many backgrounds communicate as they consider their system of existence. It is a way of teaching and sharing systems concepts, connecting the kids in school with the scientists, computer programmers, and public policy leaders. Maybe the time is right for generating a new perspective in rising generations with energy systems as the means for teaching science, economics, and public affairs in a unified way.

MAXIMUM ECONOMIC VITALITY WITH MAXIMUM POWER SYMBOLS

Finally emerging in public consciousness but still not clearly stated in our religious and ethical principles is a realization that humans are part of an environmental process that is so symbiotic that vitality and survival requires that each serve the other. When the feedbacks of human service to the environmental system are maximum then the power of the system as a whole is maximized and the economy is vital. There are still those that think environmental welfare and jobs are in competition. Energy systems education can show how to build a mutually helpful system.

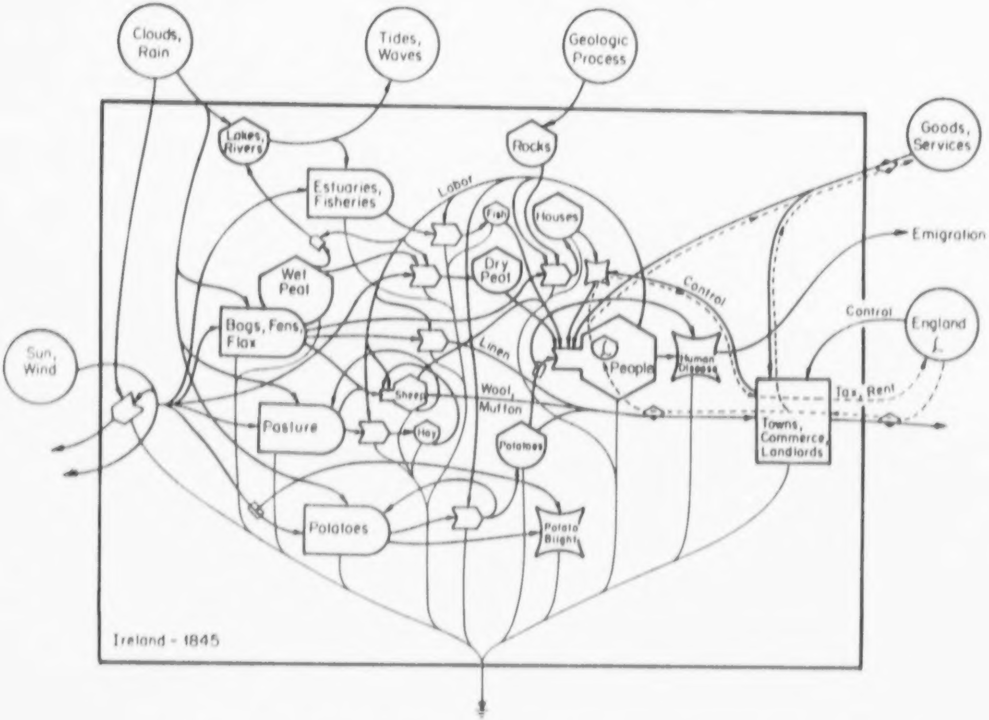

Clouds, Rain
Tides, Waves
Geologic Process
Goods, Services
Lakes, Rivers
Rocks
Estuaries, Fisheries
Labor
Fish
Houses
Emigration
Wet Peat
Dry Peat
Control
Control
England
Bogs, Fens, Flax
Linen
People
Human Disease
Sun, Wind
Sheep
Wool, Mutton
Tax, Rent
Pasture
Hay
Potatoes
Towns, Commerce, Landlords
Potatoes
Potato Blight
Ireland - 1845

Figure 2. Ireland at the time of the potato blight famine, 1845.

Figure 3 diagrams the symbiosis of humanity and nature. Humanity can continue to receive the support of the biosphere so long as its feedback of high quality services to the left reward and reinforce the basis for existence. Dual adaptation is involved:

1) some adaptation by environmental processes to accept human loading , denature and recycle wastes, etc; plus

2) adaptation by the human economy to serve the biosphere so the kind of life support system that uses humankind can compete and prevail.

The maximum power principle (Lotka, 1922) predicts that the system design that evolves is the one that feeds back human services (to the left in Figure 3) to reward and reinforce those life support functions of the biosphere that are the basis for society. The surviving systems are those with maximum symbiotic reinforcement. Environmental systems and human cultures survive that become a part of the efficient symbiosis, each reinforcing the other. Contributing to the maximum power of the symbiotic system is the priority for survival of members of the system.

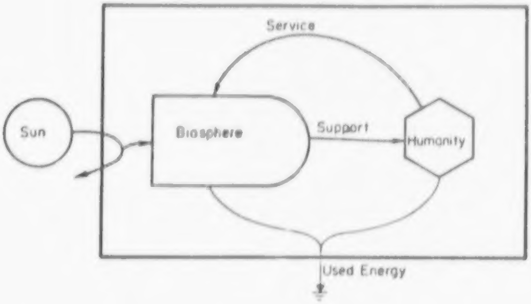


Figure 3. Symbiosis of humanity and nature

UNITY OF ENVIRONMENTAL AND ECONOMIC SYSTEMS

Typically, models of environmental systems omit money and economic models omit any constraints due to energy and other resources. The real worlds has them both. Any meaningful models must include both and the effect each has on the other. Both are included in Figure 2.

Figure 4 shows a minimodel of the world economy with two contributing production pathways: The first is the work of the environmental systems contributing to the assets of the system without much human involvement until the end of the process. The model shows the general cycle of materials from wastes being recycled and utilized by the environmental process, money involved is small. Money is only paid to people.

The second production pathway in Figure 4 is accompanied by the circulation of money, as a counter-current. This pathway is the work of people in the economic system also contributing to the total assets.

Obviously, neither production process alone accounts for all the values generated. Obviously, too, the ultimate level of development depends on the amount of incoming resource from the outside source. The manner by which the system feeds back autocatalytically to increase inputs and efficiency is controlled by the way money is manipulated.

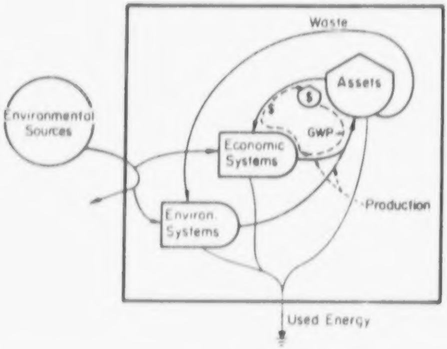


Figure 4. Environmental and human service basis of the economy. GWP = Gross World Product, measuring the world circulation of money for human services.

UNIFICATION OF ENVIRONMENTAL AND ECONOMIC VALUE CONCEPTS

Many public policy decisions are made using economic value measures, whereas there is a large body of opinion, both technical and public, that these measures do not represent the contribution of the environmental inputs to economic vitality. What is needed is a unified value system, one that expresses traditional economic values and the inputs to the economy not evaluated by market values. Figure 4 illustrates the need. If the macroeconomic circulation of money can be related to the resource use that makes it possible, then a dollar equivalent of resource can be calculated. To do this, all the input resources have to be represented with a common measure in proportion to their substitutability.

We have an energy-based concept that does this which we now call "EMERGY" spelled with an "M". All goods, commodities, materials, etc. are expressed in units of the solar energy required to make them at a competitive rate. The solar joules required for a stock or a flow is defined as the SOLAR EMERGY in SOLAR EMJOULES (sej). Formerly discussed under the name "embodied energy" we owe the name EMERGY to David Scienceman, University and Schools Club, Sydney, Australia, who recognised that a new fundamental quantity needed a new name.

After all the inputs to an economy are evaluated in units of solar EMERGY, the ratio of solar emergy to dollars of the gross national product is evaluated. For example, the ratio of EMERGY to dollars for 1980 was 2.6 E12 solar emjoules per U.S. international dollar. This ratio may be used subsequently to express any environmental or economic input as the fraction of the national GNP due to that input. Conversely, the ratio may be used to estimate emergy flows from data on money paid for services.

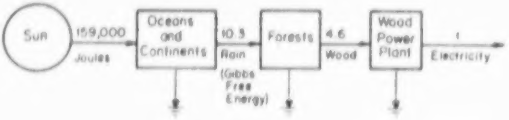
Since emergy may be calculated for environmental inputs, unpaid human services, and for paid services, it can be used to compare values and make decisions based on highest combined values to the whole system.

The contribution of an input resource to the gross national product is defined as MACROECONOMIC value. The macroeconomic value is a large scale value and is quite different from the microeconomic marketplace values which are the monies paid to humans for their services in facilitating a resource input. The macroeconomic value is often inverse to the microeconomic value. For example, oil had maximum macroeconomic impact on the economy when it was cheap to process and with low microeconomic value.

TRANSFORMITY, A QUANTITATIVE SCALE FOR QUALITY

The emergy per unit energy is defined as "transformity" and is an intensive measure of value. As one passes up the hierarchical scale from small realms to larger ones, the energy of the transformed product decreases, but the transformity increases. For example, in a hectare of grassland, the energy flow decreases as one goes from sun to grass to sheep to shepherd. The EMERGY of all products from the same hectare of resource is the same, but the transformity (=EMERGY/unit energy) increases. The shepherd's work is the most valuable on this scale. Transformity is a scale of value, making energy quality quantitative.

In Figure 5 is given a numerical example, the conversion of earth's resources to rain to forest to wood to electricity. As the solar energy flow of 159,000 joules is transformed to higher quality items, the energy decreases to 1 joule, but the transformity increases to 159,000 emjoules per joule. Since the unit of EMERGY is defined as the emjoule, the unit of transformity is emjoules/joule. If emergy is given in units of solar energy, then the units are solar emjoules for emergy and solar emjoules per joule (sej/j) for solar transformity. Some people may prefer to work in emergy units of other types such as coal emergy or electric emergy.



Solar Transformities in solar emjoules per joule (sej/j):

$$\text{Rain} = \frac{159{,}000 \text{ solar joules}}{10.3 \text{ rain joules}} = 1.54\text{E}4 \text{ sej/j}$$

$$\text{Wood} = \frac{159{,}000 \text{ solar joules}}{4.6 \text{ wood joules}} = 3.46\text{E}4 \text{ sej/j}$$

$$\text{Electricity} = \frac{159{,}000 \text{ solar joules}}{1 \text{ electricity joule}} = 15.9\text{E}4 \text{ sej/j}$$

Figure 5. Example of chain of energy transformations in a wood power plant at Jari, Brazil (Odum and Odum, 1983) showing calculation of solar transformities.

EVALUATING ENVIRONMENTAL FLOWS WITH AN EMERGY ANALYSIS TABLE

After a systems diagram of an environmental system, main pathways and stored quantities are identified. Then each item is analyzed as a line in an EMERGY ANALYSIS TABLE. Table 1 is an emergy analysis table used to evaluate some of the pathways in the Irish system in Figure 2.

The first column has the raw data in grams, joules or dollars. The next column has the transformities taken from our reference table. Each transformity was obtained from emergy analysis of a system where the product was the item needing transformity evaluation. The wood-electric power plant in Figure 5 is an example.

In the next column the transformities were multiplied by the raw data to obtain the emergy values. Emergy may be calculated for flow rates per unit time or for storage reserves.

Finally, in the last column macroeconomic value was calculated. It was obtained by dividing the emergy value by the emergy to dollar ratio. The emergy-dollar ratio used was for 1980 United States dollars.

Table 1
EMERGY ANALYSIS EXAMPLES FROM IRELAND OF 1845
In one hectare in a year

Note	Item	Raw Unit	Transformity sej/unit	Solar Emergy E14 sej	Macrovalue E9 US$ 1980
1	Sunlight	2.9 E13 j	1	0.29	11
2	Rainfall	5.0 E10 j	1.54 E4	7.7	296
3	Potatoes	9.3 E10 j	8.3 E3	7.7	296
4	Mutton	2.5 E8 j	1.7 E6	4.3	166
5	Farm Labor	250 person-days	3.1 E12	7.8	300
6	Peat, 1 m	1.84 E13 j	2.7 E4	4968.0	191,038

Footnotes:
Magnitudes of raw data estimated from Mitchell (1976). Items 1-5 are all part of the same rural production-consumption web running on the same solar emergy of climatic inputs. To add these items would be double counting.

1 Sunlight: Solar Transformity = 1 by definition.

2 Rainfall: (1000 mm/y)(1 E4 m2/ha)(1E3 g/mm/m2)(5 j Gibbs free energy/g)
= 5 E10 j/ha/y;
Transformity from world hydrology web (Odum and Odum, 1983)

3 Potatoes: (9 E6 g/acre)(1 E4 m2/ha)(0.25 dry of fresh)/(4.05 E3 m2/acre)
x (4 kcal/g)(4186 j/kcal) = 9.3 E10 j/ha/y
transformity from solar emergy of rainfall in line 2
= (7.7 E14 sej/ha/y)/(9.3 E10 j/ha/y) = 8.28 E3 sej/j

4 Mutton: assumed 1/5 of modern New Zealand; transformity from New Zealand energy analysis of sheep (Odum and Odum, 1983)

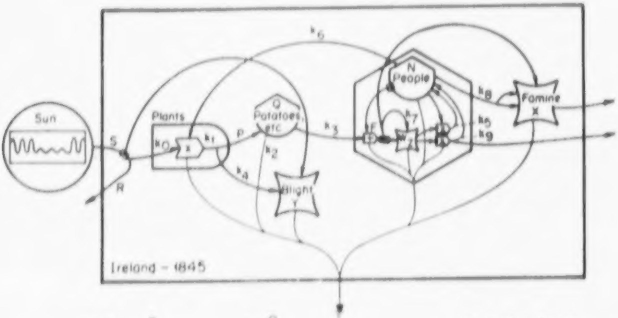
5 Farm Labor: 19th Century potato labor from Mitchell (1976)
Solar Emergy of a day's labor obtained from solar emergy of rainfall over Ireland prorated over 7 million farm workers and 300 workdays/ha:
(7.7 E14 sej/ha/y)(8.44 E6 ha in Ireland)/(300 workdays/ha)/(7 E6 people)
= 3.1 E12 sej/person-day
Solar transformity = 3 E12 sej/(2000 kcal x 4186 j/kcal) = 3.6 E5 sej/j

6 Harvest of 1 m of peat in a hectare of bog; data on density and dry weight from van Eck, Govers, Lemaire, and Schaminee (1984)
(1 m)(1 E4 m2/ha)(0.15g/cm3)(0.65 dry fraction)(4.5 kcal/g dry).
(4186 j/kcal) x (1 E6 cm3/m3) = 1.84 E13 j/ha. Only a small fraction of this would be used by people on a typical hectare in a year.

7 Deposit formed at 1.5 mm/yr, requiring: (1000mm/m)/(1.5 mm/y) = 666 y;
Transformity from total of solar emergy of rain over period of formation.
(7.7 E14 sej/ha/y)(666 y)/(1.9 E13 j/ha/y)=2.7 E4 sej/j

SIMULATION OF MACROSCOPIC MINIMODELS AS CONTROLLED EXPERIMENTS

The models that people carry in their heads and use to make predictions and decisions are simple. They have only a few quantities varying. In other words, they are macroscopic mini-models like that in Figure 6. By diagramming these explicitly, they become clearer to the owner, more readily understood by others, and the assumptions and inclusions clear. Clarified models can be shared and become a means for group concensus and motivation.

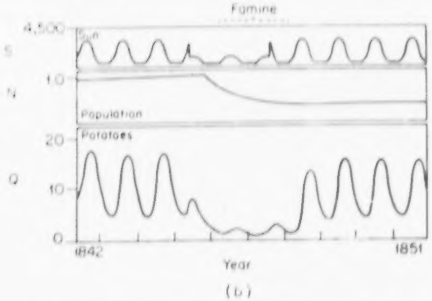


$$R = \frac{S}{(1 + k_0 N)} \qquad F = \frac{Q}{N} \qquad P = k_1 RN - Yk_4 P$$

$$\dot{Q} = P - k_2 Q - k_3 \left(\frac{Q}{N}\right) N \qquad P = \frac{k_1 RN}{(1 + Yk_4)}$$

$$\dot{N} = Wk_5 \left(\frac{Q}{N}\right) N - k_6 RN - k_7 N - Xk_8 N^2 + Zk_9 \left(\frac{Q}{N}\right) N$$

(a)



(b)

Figure 6. Simulation minimodel of Irish potato crisis. (a) Systems diagram; (b) ten year simulation, 1842-1851 with sunlight reduced to 30% 1845-1847; S, sunlight, kcalories/m2/day; N, population density per hectare; Q, potato stock, tons per hectare.

In the sciences of small phenomena, physics, chemistry and microbiology, controlled experiments are principal means for identifying mechanisms and causes. In the controlled experiment everything is held constant except the fact of interest. With large environmental systems and society, direct experimentation is rarely possible. Nor can variables that are not of interest be held constant.

The symbols have mathematical equivalents, and these have computer program equivalents. Thus, the minimodels can be manipulated on microcomputers, simulating various conditions and combinations. Simulation of a minimodel shows what the system would do if the variables were only those included in the model and working as arranged with the symbols. These minimodels are also different from many of the basic models of environmental science or economics by including both money and commodities, each represented explicitly.

An example of a simulation minimodel of the Irish potato blight famine is given in Figure 6. It is a simplification of the more complex diagram of Figure 2. Extensive summer rains with inadequate sun for potato growth released an epidemic of potato blight. Food shortage and inadequate sun for drying hay and winter peat fuel released human disease epidemics. The population of nearly eight million was decimated to three million by deaths, emigration and reduced reproduction. The simulation model generates such a scenario in a simplified manner, helping to show some main principles involved in carrying capacity questions.

Minimodel programs (Appendix) for Figure 6 are just a few lines and can be studied by busy people who can manipulate their microcomputers in the same time that they would normally study their mental verbal model of the same phenomenon. They can write and adapt their own program models.

COMMON GROWTH PARADIGMS

In our society and in our education there are several growth paradigms that guide our visions of the future. These paradigms are simple models shared among large segments of our population, often taught in the schools. Often those who see infinite substitutability of resources have an exponential growth model for their mental concepts. Those most concerned with environmental systems running on renewable resources have a succession-to-climax model as their main reference paradigm. Yet others concerned with populations find logistic paradigms related to crowding of populations where resources are seen as a static realm to be divided.

HIERARCHICAL PULSE-CLIMAX GROWTH PARADIGM

Because we often isolate parts of our system for consideration, we see growth without regard to the way systems are hierarchically nested. Increasingly, however, a different paradigm is being recognised for most systems, one that is more general, requiring simultaneous overview of more than one level of the natural hierarchy in one's mental models. See Figure 7.

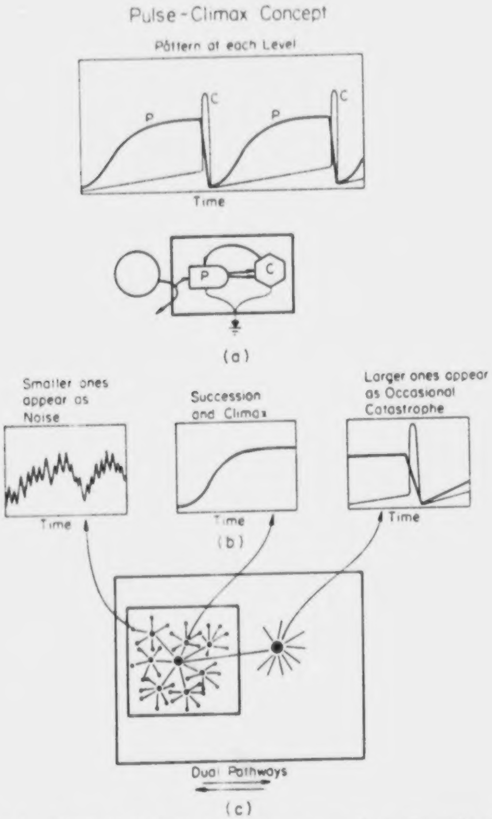

Pulse-Climax Concept
Pattern at each Level
P
C
P
C
Time
P
C
(a)
Smaller ones appear as Noise
Time
Succession and Climax
Time
(b)
Larger ones appear as Occasional Catastrophe
Time
Dual Pathways
(c)

Figure 7. Relativity of noise, climax, and catastrophe to the scale of an observer. (a) Alteration of production and consumption pulses found at all levels; (b) appearance of the pulses of smaller and larger scale systems to an observer at an intermediate scale of view; (c) spatial pattern of three levels of hierarchy.

Because small realms turnover and oscillate more rapidly than the larger realms to which they belong, the same pattern of growth among the smaller components appears different from that at one's main level of consideration and different again from the oscillations of the larger systems in which one is embedded.

Because small realms turnover and oscillator more rapidly than the larger realms to which they belong, the same pattern of growth among the smaller components appears different from that one's main level of consideration and different again from the oscillations of the larger systems in which one is embedded.

Apparently the normal pattern among most if not all systems is an alternation of production and consumption. There is a long period of production excess followed by a pulse of consumption excess. See Figure 7a. This may be due to the way this maximises both processes - in effect maximising power and resource availability in the long run.

The nature of production is that it is of smaller units compared to the consumers which are higher up in the hierarchy with larger sizes and times of replacement and oscillation. How these realms are seen by one at a particular size realm depends on whether one is looking down to the parts or up to the larger realms in which one is a part. As Figure 7b suggests, the oscillations and pulses in the smaller realms appear as noise, easily filtered out at one's higher position.

The oscillatory pulse at one's own scale of time and space looks like "S" shaped succession-to-climax growth for most of the period of the cycle.

The normal pulse of consumption of the next level is viewed as a catastrophe (Figure 7b-right) to one ill adapted to it. A pulse of use by a higher level of consumption is seen at a much smaller level, where observation time is short, as a time of steep accelerating growth that seems to have no limit.

For example, consider growth of forest trees. The growth and replacement of cells in the leaves is oscillatory but is seen as noise to a level that recognises trees. A long period of succession develops mature trees (climax). However, when a major tree falls, it appears as a catastrophe.

Figure 7c may be helpful in visualizing the spatial aspects of system levels. Turnover is less as units are larger, their territories larger and the times between consuming pulses are longer.

If the hierarchical pulse-climax concept is the general paradigm for viewing environmental systems and humanity, prognoses of items in the future ought to be keyed to their positions in hierarchy. Relative position is calibrated by evaluating the time constraints (turnover time).

If the rapid growth of resource consumption and assets of the world economy is a consumption pulse of a larger system, we must realize it will crest and return to a long period of excess planetary production again.

The consumption pulse may be catastrophic, but it is a predictable pattern amenable to human cultural adaptation.

A COURSE IN UNIFIED ENVIRONMENTAL SCIENCE

In order to unify teaching of environmental sciences, microcomputers, mathematics, economics, and systems concepts in the context of real world issues facing students, a new text for a new course has been developed. It started with a project in New Zealand in 1978 in a Department of Education project coordinated by Graeme Scott of the Environmental Resource Center of the University of Canterbury. The booklet, "Energy and Environment in in New Zealand" (Odum, Scott, and Odum, 1979) has been in use in many New Zealand schools.

In 1983 a version was adapted to Florida with testing in several community colleges and high schools. In summer 1985 a National Science Foundation workshop was held in which 22 teachers helped rewrite the material as a generic text suitable for any location in the world. Also prepared was a Florida supplement containing local information and activities. These materials are being tested in Fall, 1985, to be followed by another workshop in 1986 to revise the final product. Thereafter the text can be used in many states and countries by preparing a local supplementary pamphlet to go with the generic text just as we did for Florida.

The course starts with the energy systems symbols and the diagramming of a forest ecosystem. After establishing principles of hierarchical food chains, energy laws, recycling, maximum power, feedback controls and growth models, students learn to write BASIC programs on microcomputer and examine the larger scale environmental-economic system of their state - using the energy systems diagrams and the EMERGY evaluations to show perspectives as to what is important. The course materials provide for "hand simulation", a tabular way to simulate growth curves when no microcomputers are available.

What is innovative is the teaching of science, mathematics, computing, and economics as a unified subject. Discussions of public policy issues makes academic and everyday life more integrated. Public affairs dealt with in an objective way becomes part of environmental science.

Perhaps we are ready for an international development of this unified course? Is it appropriate to introduce the following international proposal at this time?

A PROPOSAL FOR A SERIES OF INTERNATIONAL WORKSHOPS TO IMPLEMENT A COURSE THAT UNIFIES SCIENCE AND ECONOMICS

It is proposed that a series of international workshops be arranged under suitable international organizational sponsorship to adapt teaching materials to local conditions and implement a new introductory course, "Energy Systems and Environment". The course as recently taught in experimental workshops unifies environmental science, economics and energy systems methods, with public policy questions and perspectives. A generic text has been prepared. See contents in Table 2. The proposed international workshops would prepare supplementary booklets for each participating state or nation. See contents of an example, the Florida Supplement, in Table 3.

Table 2

Contents of the Generic Text:
ENERGY SYSTEMS AND ENVIRONMENT

Part I. Principles and Symbolic Language
  1. Systems and Symbols
  2. The Flows of Energy and Materials Through Ecosystems
  3. The Food Web of the Forest
  4. Hierarchical Levels and the Quality of Energy
  5. Production and the Maximum Power Principle
  6. and 7. Growth Models
  8. Simulating Quantitative Models
  9. Oscillating Systems

Part II. Ecosystem Types (Chapters 10-19 on World Biomes)
  10. The Ocean
  11. Estuaries
  12. Ponds, Lakes, and Streams
  13. Wetlands
  14. Cold Biomes
  15. Temperate Biomes
  16. Grassland and Desert Biomes
  17. Tropical Biomes
  18. Agricultural Systems
  19. Forest Plantation Systems
  20. Urban Systems

Part III. System Economics and Environment
  21. Primitive Tribal Systems in Historical Context
  22. Energy and Economics
  23. Environmental Basis for an Economy
  24. Economic System of a State or Nation
  25. Fuels and Electricity
  26. Alternative Energy Sources
  27. Simulating World Futures
  28. Simulating the Futures of a State or Nation
  29. Population and Carrying Capacity
  30. A Lower Energy World

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Table 3
Contents of a State Supplement Booklet:
FLORIDA SUPPLEMENT

Chaps: 1. Introduction to geography and panorama of Florida
- 2. Local examples of chapters on principles in the generic text (Chaps. 1-9 above)
- 3.-13. A chapter on each important type of ecosystem in Florida (i.e. sub-tropical evergreen forest, cypress swamps, mangrove swamps, everglades, citrus agroecosystem, cattle pastures, pine plantations, coral reefs, continental shelf ecosystems, etc.)
- 14. Indian cultures of Florida
- 15. Urban systems of Florida
- 16. Environmental basis for Florida economy
- 17. Economic system of Florida
- 18. Fuels and electricity in Florida
- 19. Alternative energy sources for Florida
- 20. Simulation models of Florida
- 21. Population and carrying capacity of Florida
- 22. Florida in a lower energy world

Florida Sources, Readings, and References

PLAN:

1. Each workshop would be held to adapt the new course and write local booklets for 10 states or nations, which have some commonalities in language and climate.

2. Each workshop would be held for a four-week period, possibly in summer. At least one of the two participants from each area should be an active instructor.

3. Two hours of each day would be instruction in content, using the existing generic text on environmental principles, energy systems, economics, models, simulation, and methods of overviewing public policy questions.

4. After group discussions of content, four hours of each day would be devoted to the writing of the supplement booklets for each area, sharing materials where appropriate. Thus a main product of the workshop would be drafts of ten state supplement booklets.

5. After the workshop, under sponsorship of a home organization, a local workshop would be held at home led by the two who participated in the international workshop. At the local workshops course content would be presented and the new supplement booklets discussed and improved. Through these home initiatives, means would be sought for implementation of the new course in local testing and regular education practice.

6. Whereas the international workshops need international sponsorship, the follow-up local workshops need local sponsorship with participation in the project arranged at the start.

SUMMARY

The contribution of the environmental scientist should be the unification of the science of environmental systems to include the economics, the larger scale-long period phenomena, the presentation of concepts in simple over-view models, simulation of policy alternatives and the inclusion of new measures of total value. For these new means of understanding and managing the economic landscape, new teaching aids are needed. For this we have a generic text under project development, "Energy Systems and Environment", which is intended for use with supplementary booklets for each state or nation. This is a unified method of introducing science, economics, computers, and the real issues of our times together. Now we propose a set of international workshops to write the regional supplements and implement the teachings with the energy systems methods for maintaining a good symbiosis of humanity and nature.

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Figure 1. Energy language symbols.

Figure 2. Ireland at the time of the potato blight famine, 1845.

Figure 3. Coupled symbiosis of humanity and nature.

Figure 4. Environmental and human service basis of the economy. GWP = Gross World Product, measuring the world circulation of money for human services.

Figure 5. Example of chain of energy transformations in a wood power plant at Jari, Brazil (Odum and Odum, 1983), showing calculations of solar transformities.

Figure 6. Simulation minimodel of Irish potato crisis. (a) Systems diagram; (b) ten year simulation, 1842-1851 with sunlight reduced to 30% 1845-1847; S, sunlight, kcalories/m^2/day; N, population density per hectare; Q, potato stock, tons per hectare.

Figure 7. Relativity of noise, climax and catastrophe to the scale of an observer. (a) Alternation of production and consumption pulses found at all levels; (b) appearance of the pulses of smaller and larger scale systems to an observer at an intermediate scale of view; (c) spatial pattern of three levels of hierarchy.

APPENDIX TABLE
Ireland Simulation Program in BASIC for Apple II Computers
See Figure 6.

```
2  REM  IRELAND 1845
3  HGR : HCOLOR= 3
5  HPLOT 0,70 TO 278,70
6  HPLOT 0,0 TO 0,159 TO 279,159 TO 279,0 TO 0,0
8  HPLOT 0,30 TO 279,30
20  REM  SCALING FACTORS
21 I = 10
23 T0 = 13
25 S0 = 150
30 Q0 = .4
35 N0 = .03
50 Q = 15
55 N = .95
60 S2 = 2500
70 W = 1
100  REM   COEFFICIENTS
105 K0 = 18.8
110 K1 = 2.2E - 3
115 K2 = .002
120 K3 = .007
125 K4 = 2
130 K5 = 8.1E - 6
135 K6 = 1.6E - 7
140 K7 = 6E - 5
145 K8 = 2.5E - 3
150 K9 = 2E - 6
200  REM  PLOTTING
220  HCOLOR= 3
250  HPLOT T / T0,30 - S / S0
260  HCOLOR= 5
270  HPLOT T / T0,70 - N / N0
280  HCOLOR= 1
285  HPLOT T / T0,160 - Q / Q0
300 C = .3
301  IF T < 1180 THEN C = 1
302  IF T > 2010 THEN C = 1
305 S1 = C * (800 + 2000 *  SIN (T / 60))
306  IF S1 < 0 THEN S1 = 0
307 S = S1 + 200
308 R = S / (1 + K0 * N)
309  IF D > 110 GOTO 312
310  IF D > 100 THEN S2 = S
312  IF S2 < 1500 THEN Y = 1: REM  CLOUDS CAUSE POTATO BLIGHT
313  IF S2 > 2000 THEN Y = 0
314 F = Q / N
315  IF F < 5 THEN X = 1: REM  FAMINE
316  IF F > 5 THEN X = 0
317  IF X = 1 THEN W = 0
318  IF X = 1 THEN Z = 1: REM  LOWER BIRTH RATE
320 P = (K1 * R * N) / (1 + Y * K4)
330 DQ = P - K2 * Q - K3 * (Q / N) * N
340 DN = W * K5 * (Q / N) * N - K6 * R * N - K7 * N - X * K8 * N * N + Z
   * K9 * (Q / N) * N
360 Q = Q + DQ * I
365 N = N + DN * I
370 D = D + 1
375  IF D > 365 THEN D = 0
380  PRINT "Y="Y;" X="X;" W="W;" Z="Z
385  PRINT DN
390 T = T + 1
395  REM  GO BACK AND REPEAT FOR THE NEXT TIME INTERVAL
400  IF T / T0 < 279 GOTO 200
```

THE CHANGING ROLE OF MATHEMATICS IN A B.Sc. ENVIRONMENTAL STUDIES DEGREE - A PERSONAL VIEW

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INTRODUCTION

Mathematics plays an important role in most if not all undergraduate environmental studies and science courses by developing technical skills in data analysis and inculcating conceptual ideas which may have an integrating potential. However, most students have no formal mathematics beyond O'level and often find the subject within an environmental degree course irrelevant and boring. This paper examines the progressive development and refinement of mathematics within the B.Sc. Environmental Studies course at Sunderland, discusses the problems encountered and evaluates the radical action taken.

The B.Sc. course in question has been operating under CNAA regulations since 1974 with quinquennial reviews in 1979 and 1984. These dates mark important phases in the refinement of the role of mathematics accompanied in the latter date with a structural change in the scheme. The environmental studies course at Sunderland is an integrated course embracing physical and social sciences in an interdisciplinary framework with specialist final year units. There is a two A'level entry but many students have no mathematics beyond O' level.

PHASE 1 1975-1979

In this phase, Mathematics, Statistics and Computing were treated as three different subjects and taught by three different people in a formal manner. Each subject was taught for one hour per week for two years on the three year course. They were assessed by a three hour examination at the end of each year plus a computing project. The subjects were not popular with the students and there was a high failure rate in this area.

The causes of these problems can be analysed under three headings:-

(a) Syllabus content
(b) Method of teaching
(c) Assessment

(a) Syllabus content
Mathematics included Algebra, Functions and Graphs (including more than one variable), Trigonometry and Calculus (including differentiation, Integration and Taylors Series).

It was optimistic to think that O'level standard students could absorb such mathematics in 60 hours spread over two years. Was it necessary for these students to know about functions of several variables or for them to be able to use various integration to solve differential equations? Admittedly differential equations occur frequently in models of the environment but they are now mostly solved by computers. Environmentalists should be aware of the existence of such equations but do not need to be solution experts.

Statistics included:-

Standard Data Analysis up to means and standard deviation, Regression Theory (linear and multiple), Statistical Testing (including Chi-squared), Hypothesis Testing and Sampling.

Few people could argue about the relevance of such topics. How was it then that the students did not or would not accept them? This question is best answered under the section discussing teaching methods.

The computing section taught BASIC for use on a DEC 11/40 mini computer.

(b) Method of Teaching

A case could be made out for the inclusion of most of the topics mentioned above in any environmental syllabus except perhaps for some of the more formal mathematics. The fact that students did not perceive this, means that there must be another problem - the manner in which it is presented. This is very difficult to solve. Mathematics (including Statistics) is considered by mathematicians to be a linear subject where progress is made in logical steps and one level cannot be fully understood without mastery of the lower levels.

I, myself, am a mathematician and wholeheartedly agree with this statement. I also recognise, however, the importance of the word 'fully' in the sentence. Surely, there must be a difference in teaching mathematics to students who are taking a degree in (and thereby presumably intending to devote their career to) mathematics and those students who need mathematics as a tool to master their own subject. The question can be most clearly exemplified by the chi-squared test which occurred in the statistics course at about the fiftieth week by which time the students would 'know enough to fully understand' whereas the biologists were needing it (and using it regardless) in the first five weeks!

Of course mathematics can be taught as a series of theorems and proofs and the whole edifice constructed brick by brick held together by logic, clarity and precision. But this is not the only way. Other people might not be interested in the construction of the edifice but more interested in living in it and using it. It can be taught as a useful and essential tool. Students can spend two weeks studying excellently prepared booklets explaining everything about means and standard deviations and yet not connect it with any of the data analysis they are doing, for example, in their ecology units. It must be appreciated by mathematicians that the language of mathematics has special meanings and is not appreciated by everyone. When teaching mathematics to such as environmental students, the choice of words and especially the examples is so important but often overlooked.

(c) Method of assessment

After struggling through two years of mainly bewildering theory, the student was faced with the prospect of a three hour mathematics examination. Most did badly. In retrospect this was not very surprising. Their equivalent on a mathematics degree course would have had three or four more years practice and answering this type of question than them because there are techniques that help to pass mathematics exams.

The other problem is that the examination will test whether the students understand the mathematics but what should be tested is whether the students can link the mathematics to other units in the course and see how it is and can be applied. This needs a different form of assessment.

PHASE 2 1979-1984

Two basic but related questions had to be answered:-

(a) Is this just a service course for other units?
(b) Does it have a meaning and usefulness in its own right?

When questioned in detail about the exact mathematics that was needed by each other subject area, the answer was surprisingly little. Most lecturers wanted numerate students who could handle 'basic' statistics and one or two lecturers said that knowledge of first order differential equations would be useful but not essential. The decision was thus taken that this was not just a service course and the answer to question (b) was 'YES'.

To counteract the problem of too many different lecturers, the mathematics and computing were taught by the same person with the statistics still in the hands of a pure statistician. The problem about the relevance of the mathematical content and the teaching methods were tackled by introducing mathematical modelling. It still ran for the first two years but because of the modelling input, the assessment was changed to continuous assessment with no formal examinations.

The aims for this new mathematics/computing syllabus were:-

i) To introduce the student to the ideas of mathematical modelling;

ii) To provide enough mathematics to produce and study simple models;

iii) To enable the student to appreciate the role of the computer in Society;

iv) To teach the techniques (quantitative) needed for the rest of the course.

Mathematical Modelling (Moscardini, 1985) has many meanings. It is currently a buzz word and because of this, it is looked upon with suspicion by some mathematicians and regarded as peripheral to 'real' mathematics. I disagree with this view and regard mathematical modelling as real mathematics which includes 'pure mathematics' as a subset. The interpretation placed on mathematical modelling is illustrated by Figure 1.

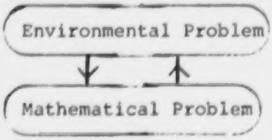

Figure 1 : Mathematical Modelling

Environmental (or real world) problems abound and for most of them there is a correspondence or matching with a mathematical problem. But this matching is not perfect. The mathematical problems does not perfectly represent the environmental problem - assumptions have been made. There was a process involved in arriving at the mathematical problem - assumptions have been made. There was a process involved in arriving at the mathematical problem from the environmental one. This process of how to arrive at the mathematical problem and (after having solved it) how to match the mathematical solution with, the environmental problem is what I term 'mathematical modelling. I perceive the process as being most important. The solution stage is where detailed, advanced and complicated mathematics can occur. This should then be left to the expert or simple solutions attempted. As such the relevance to an environmental studies course is obvious. The new syllabi accordingly reflected this thinking and included under Mathematics and Computing:-

Meaning of Mathematics
Graphs as models of real-life situations
Computing as a modelling tool
Rates of change
Population Models
Use of home produced software
Simulation - Monte Carlo Method.

The statistics course was more or less as before except for assessment. No formal examination but two tests at the end of each term and a project.

The relevance of the new scheme can now be appreciated. The content has changed although the calculus is still being taught under 'Rates of Change' and Algebra is still present under 'Graphs'. But both these topics are being continually reinforced by using environmental examples such as population growth and simulations. The computer is now perceived as a tool which can help in the solution stage not as a modern piece of technology. But most of all the whole emphasis of the course is changed. It is changed because the mathematics is presented as a tool to help and the language used was the language the students were familiar with from other courses. Once the students' confidence has been gained they were quite prepared to accept specialist and 'pure' elements which were important and essential for their future work. In this way a lot of useful techniques were introduced.

As a result of these changes, the mathematics and computing became more popular among the students. It integrated better with other units and evidence of this was the appearance, for the first time, of quantitative analysis in the final third year projects. Also applied problems were created for first and second year projects.

An example of a project tackled by the second year of such a course is as follows:-

> A steelworks wishes to discharge polluted water into a river. Local authorities state that pollutant concentration must be less than 0.0005 g/m^3 under all circumstances. It is known that plant discharges vary between 10^{-3} and 10^{-2} g/m^3. The firm decides to use a biological treatment system in a single well mixed tank. Investigate this design. What size of tank is needed? Would two smaller tanks suffice or be more effective?

This problem uses quite advanced mathematics involving the solution of a system of non-linear, linked, first order differential equations. This is far above the normal ability of students on the course but was successfully completed by them. The students were first shown how to build equations such as:-

> Rate of change equals input-output.

When they had obtained the equations, they used home produced software to solve them on a computer which also produced graphs. The students' task was to understand how the equations came about and how to interpret the graphical results. It did not matter that they did not understand the situation process. This approach emphasises understanding rather than the technique. There are also strong obvious links with biology, chemistry and social sciences.

The biologist and the chemist could investigate the actual mechanisms by which pollutant water is treated and evaluate the effectiveness of these processes. The social scientist could discuss attitudes towards setting up such treatment and the effect that various pressure groups do or do not have. The economist will study the financial implications of building these tanks and the knock-on effect into profits and consumer prices. The political scientist will discuss the powers of local councils viz a viz such firms, the effectiveness of local laws or multinationals etc. Thus, the project can integrate the differing strands of a typical second year environmental course.

The changes in the syllabus and the change of emphasis in the method of teaching necessitated a different form of assessment. The overall aim of the unit was to demonstrate how mathematics and computing were relevant to environmental studies and the best way of examining this was to encourage participation throughout the year. This continuous assessment was introduced in all mathematics, computing and statistics units. This did not result in an easy passage for students. Good, thoughtful, planned assessment is a very accurate pointer to the students' capabilities and failure results in a resit of the whole year not another chance in September.

PHASE 3 1984-

Although the Environmental Studies Degree was successful in both attracting students and producing good 'environmentalists', a questionnaire amongst students and staff revealed that the course was still perceived as two fragmented modules, especially in the first year and the integrating philosophy of the course was not being fully obtained.

Over the previous three years, the mathematics department had initiated and run an M.Sc. degree in Mathematical Modelling and Computer Simulation. As the environment is such a fertile area for models a lot of experience had been gained by staff in the teaching of modelling to students. Simultaneously, research interests amongst myself and colleagues had focused on the role of systems theory in modelling especially the role of systems dynamics and causal loop programming.

This expertise together with the success of projects such as the one mentioned in section 3 helped to convince the syllabus team that the quantitative methods section could form a central pillar of the course around which integrative links could be formed. After much discussion, the following innovations:-

i) A subject named Environmental Techniques would be made a compulsory subject for all three years of the course.

ii) A two man team would cover all mathematics, statistics and computing.

iii) The twin aims of this module would be to provide an integrative framework for the course whilst also supplying techniques needed in other modules.

The new module (Environmental Techniques) is now examined by continuous assessment.

YEAR 1

The module is divided into two sections:-

i) Data Collection and Analysis
ii) Environmental Systems and Modelling.

Data Collection and Analysis includes all the statistical theory needed by the students. The problems discussed in Section 2b were met head-on. The teaching was more condensed and taught in a much more practical and relevant manner. The emphasis was switched from the detailed understanding of the processes to the understanding of where and when certain tests are used. The course was helped by the purchase of an excellent software package called Minitab (Ryan 1982) which also blurred the previously hard defining lines between computing and statistics. This approach is still being tested but signs so far are encouraging.

The Environmental Systems and Modelling option again relied heavily on the computer. The Polytechnic has excellent computing facilities and each student has access to a BBC micro, minicomputers (VAX) and mainframes (ICL) are also available but the opinion of the author is that the BBC is such an easy machine to operate that it is an excellent vehicle for introducing computing. The students are therefore given a thorough grounding in BASIC. They are then introduced to the basic ideas of Mathematical Modelling (as discussed in Section 3) and systems thinking. The concepts of positive and negative feedback are discussed. This leads to simple causal loop diagrams which are then written as differential equations and solved on the BBC. By the end of the first year, the student should be well versed in the user of BASIC, capable of spotting feedback loops and able to produce a set of difference equations for solution. This, then, lays the foundations for the study of systems dynamics in the second year.

YEAR 2

Again, the module is split into two sections:-

i) Management Techniques
ii) Environmental Systems and Modelling.

The Environmental Systems and Modelling module concentrates this year on two topics: Systems Dynamics and Differential Equations. System Dynamics (Forrester 1961) was developed by Forrester at MIT in the 1950's and consists of modelling problems by a series of levels and rates. It has its own programming language called DYNAMO. DYNAMO is at heart a system of difference equations, so this whole approach follows naturally from the year one syllabus. This approach to modelling is natural and can be applied to many environmental problems. At the same time the more traditional mathematical methods of expressing change (i.e. Differential Equations) is not ignored. It is now recognised however, that it is impossible to teach the mathematical techniques concerning the Calculus in such a time limit so the emphasis is on the meaning of the symbol dy/dx and how equations can be set up. The solution routines are all contained in home produced computer software which has proved successful. It is important for the student to see both techniques and realise the advantages and limitations of both.

YEAR 3

The unit in this year concentrates on Simulation techniques and major case studies. Simulation (Pidd, 1984) is a rapidly developing subject because of the growth of cheap computing power. It is felt that students should encounter such techniques although in the time scale involved this can be little more than an overview. One of the major case studies presented to the student is exemplified by 'limits of growth' produced by the Club of Rome (Meadows 1972). This is to reinforce the importance and relevance of the first two years' work and show that it is really used in the outside world.

CONCLUSIONS

The object of this paper was to give a personal view of how mathematics should fit into an environmental degree. Several of my ideas may not find favour with other mathematicians but they are based on a decade of practical experience.

(a) Mathematics need not be just a service subject but has its own important role to play in such courses. However, because of the background of typical environmental students and because of the time allowed, the whole approach to mathematics must be different. It is important that this change in attitudes of perception takes place in the mind of the teacher in order to communicate the ideas with the students This, of course, means that traditionalists or mathematicians who have fixed ideas of how mathematics should be taught will never be successful on such courses!

(b) Rigour in mathematics teaching has to be sacrificed for applicability of the subject and suitability to the students. Sometimes the linear approach to mathematics has to be abandoned (with the attendent risks that entails) and replaced by a black box approach.

(c) Mathematics should encourage not disparage diagrammatic attempts to describe situations such as causal loop diagrams, energy diagrams, systems dynamics diagrams. To dismiss systems dynamics because it really only uses very simple, crude numerical techniques is to miss the point completely. Of course advances in numerical solution of equations have been made but these must be examined in the context of the course and students under discussion.

(d) Wherever possible, students should be encouraged 'to take the sting out' of the solution stage by using good, efficient computer software. It is no longer necessary for students to understand how equations are solved. It is more important for them to see where the equations have come from and how to interpret results.

(e) Continuous Assessment is preferable to formal examinations. Many mathematicians regard continuous assessment as a 'soft option'. This is not the case and often it is more difficult to complete for the student than the formal examination. Again the method of assessment begs the question 'what is being taught'. In syllabuses that I design, what is being taught is the usefulness and practicality of the subject rather than the many detailed methods and techniques that compose it.

To conclude, I see mathematics and statistics as an exciting, living, and challenging changing tool for analysing environmental issues and predicting results. I think the holistic viewpoint of mathematics is the most suitable for Environmental Studies but unfortunately the 'reductionist' viewpoint still prevails. However, there are signs of movement and conferences such as these may provide the impetus to change opinions so that mathematics could play a major role in the fertile field of environmental education.

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THE ROLE OF COMPUTING IN ENVIRONMENTAL SCIENCE IN HIGHER EDUCATION

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INTRODUCTION

With the rapid rise in the number of micro-computers available for personal and school use it is clear that students in the near future will not find an odd few lectures in BASIC and the desultory use of a few packages like SPSS and MINITAB much of a further education in environmental science (Unwin and Dawson, 1981). One of the major pedagogic problems confronting lecturers is to integrate computer applications into environmental science in a co-ordinated and educationally sound manner. Obviously, this problem of the application of computers in environmental science teaching raises itself at the undergraduate level as well as in postgraduate training. Hence this paper reports on the way in which computers are used in both teaching and research in environmental science based on experience gained at the University of Stirling.

In the following section the various roles which computers can play in environmental science together with the ways in which the computer can be integrated in degree level teaching are described. This general discussion of the role of computing in environmental science is then followed by an example of dynamic simulation modelling taken from an intensive course in computer modelling of environmental systems using mainframe and micro-computers. Finally, some of the possibilities for further development of the use of computers in environmental science together with the financial constraints are noted.

THE ROLES OF A COMPUTER AND ITS INTEGRATION INTO ENVIRONMENTAL SCIENCE

At its simplest level a computer is a machine which is 'capable of accepting information or data, processing the information and providing results as an output' (Dorf, 1974, 1). As is well known any computer system consists of five major components namely input and output devices and three interconnected units which make up the central processing unit. (Figure 1). The input device is often a typewriter-like keyboard which transmits the information into the central processing unit. Other input devices can be used such as floppy discs or cassette tapes. The relevant information sent by the input device to the central processing unit usually consists of a program or set of instructions written in a computer language such as BASIC or DYNAMO and includes the relevant data sets.

The 'brain' of any computing system is the central processing unit which generally consists of three interconnected modules. The

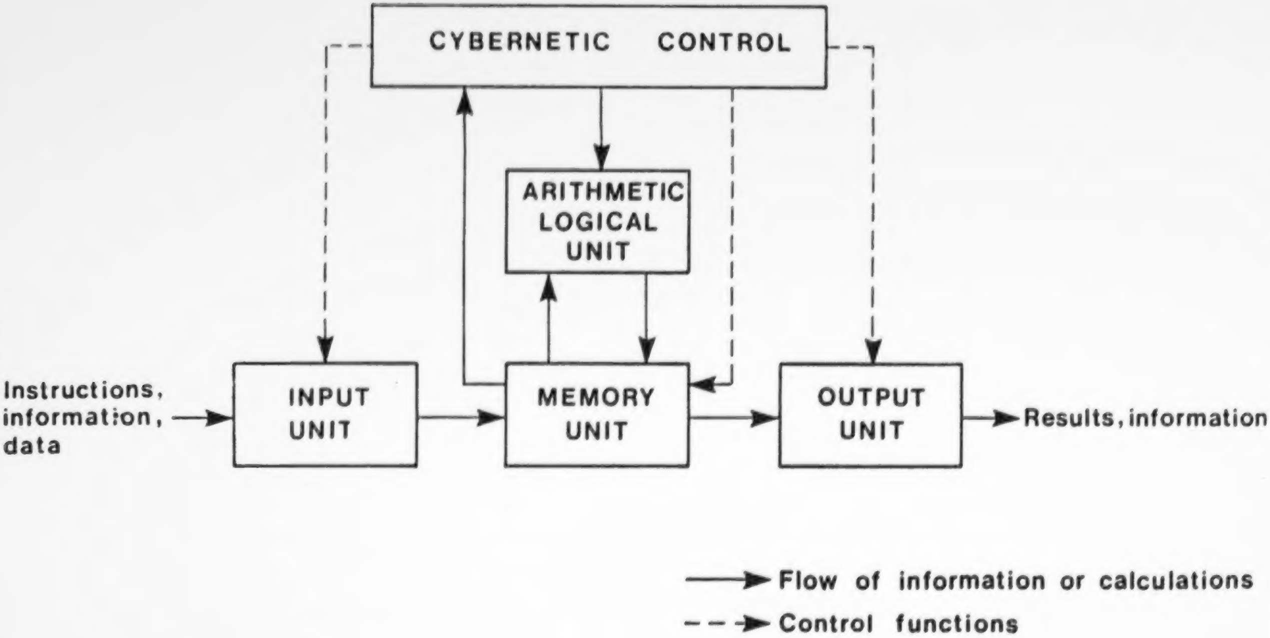
CYBERNETIC CONTROL
ARITHMETIC LOGICAL UNIT
Instructions, information, data
INPUT UNIT
MEMORY UNIT
OUTPUT UNIT
Results, information
Flow of information or calculations
Control functions

FIGURE 1 The Five Basic Units of an Electronic Digital Computer

memory unit stores the computer program and input data as well any intermediate results which are required by the user of the computer when it executes the specific job. The arithmetic unit, as the name implies, can undertake the four basic arithmetic operations as well as performing the logical operations such as ranking data or determining inequalities. The power of modern electrical digital computers is the ability of this unit to perform arithmetic or logical operations accurately, precisely, reliably and at high speed. As these operations can be executed in thousandths of a second it is obvious that there is a need to supervise these calculations automatically. This latter task is undertaken by the cybernetic control which automatically supervises the flow of information and calculations within the computer. This unit is also responsible for requesting from the memory the instructions and data necessary at each stage in the computational sequence. As these instructions are held in the memory unit, along with the intermediate results, then it is possible for a computer to modify the instructions as the calculations are processed and hence steer the entire computational operation to a definite conclusion.

Finally, the output unit provides the results in a form suitable for the user. The output of a computer can come in a variety of forms such as being displayed on a visual display unit in monochrome or colours, alternatively a hard copy of the results showing graphs, maps, tables or numerical answers are the most useful form for the user especially if the output is to form part of an undergraduate assessed work. Often, the results of a research project are stored on floppy discs or magnetic tapes for further analysis at some later date. The ways in which computers can be used effectively in environmental science will now be examined.

Generally, the use of computers can be justified in environmental science if one or more of the following six conditions are met. First, if large amounts of data or information have to be recorded as part of a data bank. Next, if a large number of calculations have to be performed on the data set. Third, if references are required on a specific problem such as the incidence of acid rain in Scotland. Fourth, if various forms of programmed learning or more broadly computer assisted learning could help in the education process. Fifth, if the environmental problem cannot be analysed in the field or laboratory then experiments of these systems can be undertaken using computer simulation models. Finally, if the results of the research or teaching exercise needs to be published, then word processing facilities can be used. The ways in which a computer can be used in environmental education will now be discussed.

At the University of Stirling, the department of environmental science has been developing the use of computers in environmental education over the past seven years (Moffat, 1982). The various ways in which both mainframe and microcomputers are used in undergraduate teaching as well as research are shown in Figure 2. As can be observed, environmental education represents one portion of the rapidly expanding world of knowledge. The expansion of the world of knowledge is doubling every thirty years and one of the major advantages of using computer systems is that it helps to keep teachers and researchers up to date with new developments in the field of environmental education.

One of the exciting applications of computing in environmental education is the use of satellites to record digital information about the ways in which the earth's environment is changing. This area of investigation is known as remote sensing and permits investigators to examine various environmental problems sensing apparatus such as LANDSAT images recorded by satellite (Cracknell et al, 1982). Nearer to earth, the recordings of, say, fluctuations in meteorological or river flow variations can be automatically recorded and then the data can be stored and subsequently retrieved and analysed from the computer system. Even small microcomputers such as an APPLE can support both of these facilities. Similarly, the monitoring of the impact of environmental policies can be aided by computer linked automatic recorders.

Information retrieval forms a second useful aspect of computer use in education. With the virtual explosion of information in scientific literature it is clear that staff are finding it increasingly difficult to keep abreast of their research fields. In the case of environmental education the Environmental Periodical Bibliography, for example, provides a convenient way of accessing the contents of periodicals and journals concerned with specific environmental problems. This particular form of information retrieval began in January 1974 and by May 1978 it contained 100,000 records and is updated bimonthly with an additional 8,000 records. Clearly, this massive bank of information can be used carefully for teaching and research purposes.

Statistical analysis and the presentation of statistical data is a third important use of computer systems. In the analysis of an environmental problem it is often useful to attempt a statistical significant relationships between two or more sets of data. At the University of Stirling, many departments have courses which introduce undergraduates to statistical analysis of data using the appropriate statistical techniques and associated computer packages such as MINITAB or the Statistical Package for the Social Sciences (SPSS). The use of these packages allows undergraduates to analyse quite large bodies of data quickly and then carefully interpret and evaluate their conclusions.

A somewhat similar use of computers can be envisaged in the presentation of statistical data by the use of histograms or linear regression graphs as well as automated cartography. This latter area of computer aided cartography has obvious benefits such as producing maps quickly and cheaply as well as allowing the maps contents to be specifically related to the users' needs. Furthermore, the use of

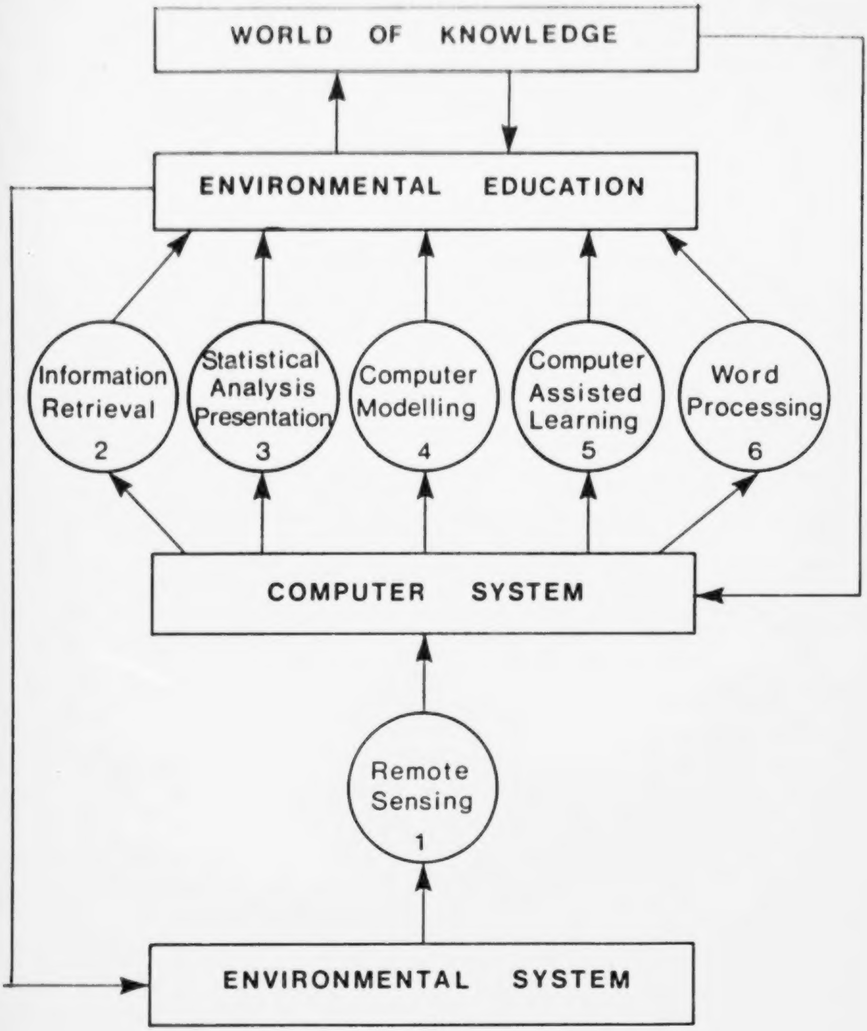
WORLD OF KNOWLEDGE
ENVIRONMENTAL EDUCATION
Information Retrieval 2
Statistical Analysis Presentation 3
Computer Modelling 4
Computer Assisted Learning 5
Word Processing 6
COMPUTER SYSTEM
Remote Sensing 1
ENVIRONMENTAL SYSTEM

FIGURE 2 The Uses of a Computer in Environmental Education

say, river channels or land use patterns to be reproduced from the computer's memory files quickly when required (Rhind, 1977).

One of the main features of environmental science is that it attempts to produce a holistic or synthetic view of a specific problem rather than a purely analytical dissection of the problem. As Odum notes, one of the great challenges to environmental education, 'is to use systems models to understand the pulsing changes in our biosphere and the role humanity can play' (Odum, 1983, 582). Hence, the computer can be used to build static or dynamic models of environmental systems so that the ways in which man's activities impinge on the natural world and vice-versa can be understood. This area of research is also taught at the department of environmental science using simulation models in BASIC or DYNAMO on mainframe and micro-computers (Bennett and Chorley, 1978, Jeffers, 1978, Wilson, 1981). This type of modelling is also useful to decision-makers concerned with making environmental management policies and subsequent monitoring of the environmental impact of these decisions (O'Riordan, 1981).

With the diffusion of computers into many areas of education it is possible to use this new tool for programmed learning or, more generally, computer assisted learning. Early research has shown that less able students are willing to spend more effort in concentrating their minds when in communication with an interactive computer system rather than in an orthodox class teaching situation (Suppes, 1966). One of the aims of computer assisted learning is not to produce students who are able to pass examinations one or two years earlier by better teaching methods. On the contrary the aim of computer assisted learning is to ensure that the student passes examinations, if required, or the coursework, in plenty of time, with a greater understanding and insight which will stand him or her in good stead later in the education system and life (George, 1970). This type of teaching does, however, require a large amount of time and great care must be taken to prepare class projects carefully and in a structured manner. Finally, one of the important aspects of any teaching or research programme is to communicate the result of the project so that other interested people can participate in the educational process. Again, the computer can be used to type articles using word processing facilities in order to speed up this important aspects of environmental education. The introduction of word processors on micro and mainframe computers at the University of Stirling can again make a major contribution to this aspect of environmental education (Adams and Haden, 1967).

Figure 3 illustrates the ways in which the six uses of computers are currently integrated into environmental science undergraduate teaching at the University of Stirling. At present undergraduates are not permitted to use word processing packages of the mainframe or micro-computer systems. Apart from this restriction it can be observed that several cells of the matrix are empty although in the near future it is anticipated that almost every course will be able to use the full potential of computers in environmental science. The vast

	COMPUTER USE					
COURSES	1	2	3	4	5	6
Remote Sensing	X	X				
Modelling			X	X	X	
Data Analysis			X			
Climatology		X	X			
Hydrology		X	X	X		
Pedology			X			
Geomorphology		X	X			
Resource Use			X	X	X	
Urban Environment		X	X	X	X	
Environmental Modelling		X	X		X	
Tropical Environment		X				
Dissertations			X	X	X	
Human Ecology			X	X	X	

KEY

1	Remote Sensing
2	Information Retrieval
3	Data Analysis and Presentation
4	Dynamic Modelling
5	Computer Assisted Learning
*6	Word Processing (not available to undergraduates)

FIGURE 3 : The Integration of Computing Into An Environmental Science Undergraduate Course

majority of the staff are able to program the micro and mainframe computers using at least one high level language such as FORTRAN or BASIC as well as use computer packages such as MINITAB, SPSS or word processing packages such as APPLEWRITER or VIEW.

AN INTENSIVE COURSE IN COMPUTER MODELLING

One of the characteristic features of the honours degree programme in environmental science at the University of Stirling is the choice of subjects offered to senior undergraduates. These intensive courses allow undergraduates to pursue six out of twelve units in the last one and a half years of the four year degree programme. One of these courses is concerned with computer modelling of environmental systems for both scientific research and environmental management.

There are three aims of the course in computer modelling. The first is to introduce students to a large and rapidly growing body of literature concerned with the development and use of computer models of environmental systems (Bennett and Chorley, 1978; Jeffers, 1978). As with other honours units, this particular aim is able to build upon the student's previous knowledge of environmetnal problems and models. The second aim is to enable students to analyse environmental systems of varying degrees of complexity and then to build elementary dynamic models of these systems. In order to achieve this aim the students are introduced to the use of difference equations, system dyanimics and DYNAMO programming. The final aim of the course is to critically examine the role of computer model building in environmental science and management. The content of the course is shown in Table 1.

In order to illustrate the ways in which computer modelling is used in environmental science a relatively simple example will be presented. As is well known, the natural waters of many industrialised nations have been enriched inadvertently with nutrients due to agricultural and industrial productive processes. This nutrient enrichment results in the growth of blue-green algae which deprived other aquatic life of oxygen in the aquatic system which, if unchecked, will eventually result in the eutrophication of the ecosystem. One of the undergraduates' exercises is to develop a simulation model of this system so that the predicted results of the growth of algal blooms can be compared with the laboratory and field collected data.

Given the verbal description of this particualr system of interest it is essential to translate the word model into a signed diagraph (Wilson, 1981). The signed diagraph or causal diagram shows the interdependence of the elements which make up the system of interest (Figure 4). This diagraph shows that the growth rate of blue-green algae (AC) is due, in part, to the availability of dissolved nitrogen available (DNC9 in the water of the ecosystem as well as influenced by a short-term store of intracellular nitrogen in the algae (PNC and ANC). These interactions combine to form a simple model of algal growth (Longman, Samson and Muur, 1979).

TABLE 1 An Outline of the Contents of a Computer Modelling Course in Environmental Science

WEEKS	LECTURES/SEMINARS	COMPUTER WORKSHOPS
1	Use of Computers in Environmental Science Methodological Review	Use of Mainframe and Microcomputer Systems
2	Causal Diagrams, Lexical and Parsing Phases Feedback	Causal Diagrams and DYNAMO Flowcharts
3	DYNAMO Programming Language	Practice with DYNAMO
4	Difference and Differential Equations	Hand and Computer Simulations
5	Elementary Models of Environmental Systems	Use of APPLE and VAX Computers
6-9	Advanced Models and Management of Environmental Systems	Use of APPLE and VAX Computers
10	Research and Ideology in Modelling and Managing Environmental Systems	

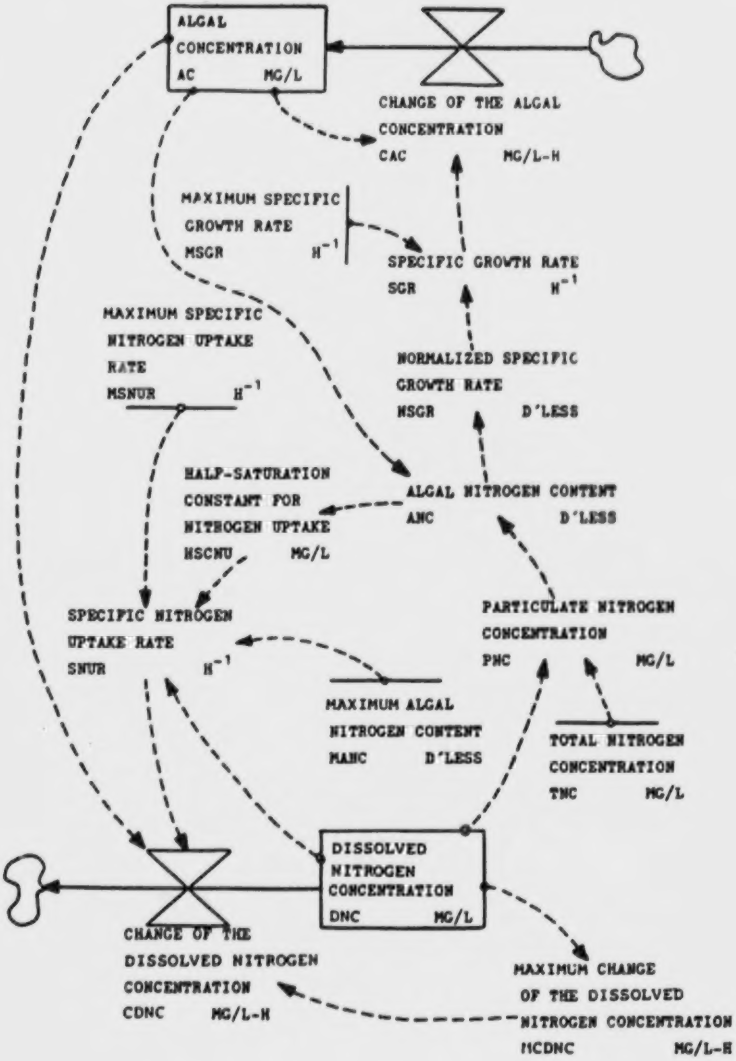
ALGAL CONCENTRATION AC MG/L
CHANGE OF THE ALGAL CONCENTRATION CAC MG/L-H
MAXIMUM SPECIFIC GROWTH RATE MSGR H^{-1}
SPECIFIC GROWTH RATE SGR H^{-1}
MAXIMUM SPECIFIC NITROGEN UPTAKE RATE MSNUR H^{-1}
NORMALIZED SPECIFIC GROWTH RATE NSGR D'LESS
HALF-SATURATION CONSTANT FOR NITROGEN UPTAKE HSCNU MG/L
ALGAL NITROGEN CONTENT ANC D'LESS
SPECIFIC NITROGEN UPTAKE RATE SNUR H^{-1}
PARTICULATE NITROGEN CONCENTRATION PNC MG/L
MAXIMUM ALGAL NITROGEN CONTENT MANC D'LESS
TOTAL NITROGEN CONCENTRATION TNC MG/L
DISSOLVED NITROGEN CONCENTRATION DNC MG/L
CHANGE OF THE DISSOLVED NITROGEN CONCENTRATION CDNC MG/L-H
MAXIMUM CHANGE OF THE DISSOLVED NITROGEN CONCENTRATION MCDNC MG/L-H

FIGURE 4 Flow Diagram of the Modified NAM-Model

The diagraph is easily translated into a DYNAMO flowchart in which the state variables or levels are shown by rectangular symbols; the rates of change by valve like symbols and the other parameters by circules (Figure 5). This DYNAMO flow chart is then readily written into a DYNAMO computer program, or a BASIC program, which can be run on a mainframe or micro-computer system (Forrester, 1961; Pugh, 1970; Moffatt, 1979; Roberts et al, 1983). At present DYNAMO is available on IBM and DEC VAX 11/780 mainframe computers as well as in ICL machines using DYSMAP. Currently, micro-DYNAMO is available on IBM personal micro-computers and APPLE II micro-computer with a PASCAL interface.

The results of this simple simulation model (Table 2) can then be compared with the relevant data for the growth of algal concentration taken from laboratory experiments. As can be observed the predictions of the model for algal concentration are in reasonable agreement with the observed data whilst the data on nitrogen concentration would need a finer temporal scale before the predicted result could be verified. As in any modelof a real world system several factors have been ignored such as the influence of temperature or light on this system. Obviously, these and other factors would need to be incorporated in a further cycle of modeldevelopment so that a more realistic model of the system could be produced.

TABLE 2 Actual and Predited Results of the Simulation Model

	Algal Concentration (Mg/L)		Nitrogen Concentration (Mg/L)	
Time	Actual	Predicted	Actual	Predicted
0	13	13	0.5	0.5
30	15	17	0.0	0.3
60	30	25	0.0	0.0
90	35	28	0.0	0.0
120	37	28	0.0	0.0

This example of simulating the growth of algal blooms illustrates the way in which computer modelling of environmental systems can be taught in undergraduate and postgraduate courses. There are, of course, a whole host of environmental problems which can be examined by the use of computer modelling including predator-prey interactions through to models of the biosphere (Jorgensen, 1979; Forrester, 1971; Meadows et al, 1974). All these problems do require a knowledge of the processes involved within the dynamics of the system of interest; the type of data and the way in which it is collected as well as knowledge about the technique of simulation modelling. It should, however, be obvious that there is further room for improvement in the types of models environmental scientists use to explain the world as it unfolds around us. These improvements in the concepts of dynamic modelling coupled with increasing versatility in computer

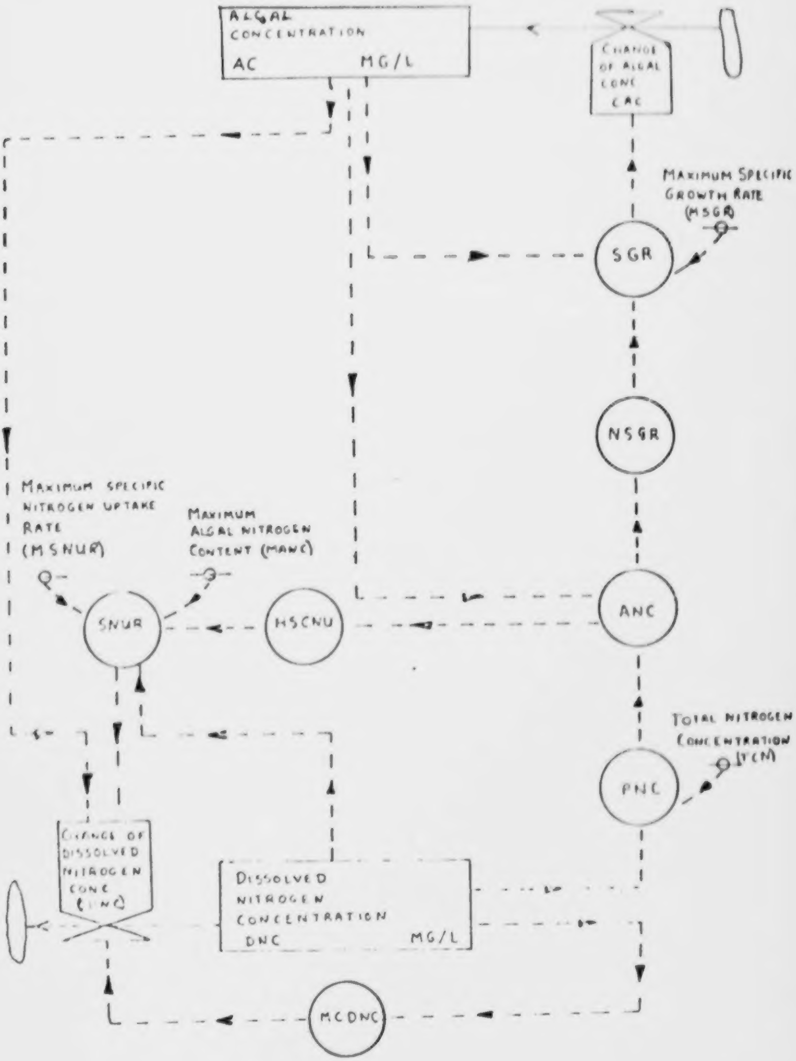
ALGAL CONCENTRATION
AC MG/L
CHANGE OF ALGAL CONC CAC
MAXIMUM SPECIFIC GROWTH RATE (MSGR)
SGR
NSGR
ANC
TOTAL NITROGEN CONCENTRATION (TCN)
PNC
MAXIMUM SPECIFIC NITROGEN UPTAKE RATE (MSNUR)
MAXIMUM ALGAL NITROGEN CONTENT (MANC)
SNUR
MSCNU
CHANGE OF DISSOLVED NITROGEN CONC (CDNC)
DISSOLVED NITROGEN CONCENTRATION
DNC MG/L
MCDNC

FIGURE 5 A Modified Model of Algal Growth (Dynamo Flow Chart)

technology hold great promise for further teaching and research into the dynamics of environmental systems (Moffatt, 1985).

CONCLUSION

This paper has examined the role of computing in environmental science in higher education. The basic functions of a computer have been described and at least six computer applications have been identified: remote sensing, information retrieval, statistical analysis and presentation, environmental modelling, computer assisted learning and word processing. The ways in which these six uses of computing have been integrated into undergraduate teaching and postgraduate research in environmental science have been described.

The details of an intensive course in computer modelling of environmental systems has been described using an example of algal bloom growth. During this final year course undergraduates are exposed to the discipline of analysing systems of interest; building and programming dynamic simulation models of these systems and then testing the output of their models with the relevant data. It has been argued that this use of computers in environmental science gives the undergraduates a good introduction into the principles of computer model building. This experience has proved to be invaluable to those students embarking upon either postgraduate research or careers which examine and manage substantive environmental problems.

Obviously, further uses of computing in teaching and research with environmental science could be developed. The automated collection of data and its subsequent analysis using portable microcomputers in the field as well as in the laboratory is technically feasible. Similarly, the introduction of computing skills in environmental science could be introduced to the large first year classes of undergraduates. The main constraints against these educationally desirable objectives has been the lack of financial support from central government. Fortunately, the University Grants Committee has obtained three million pounds for the use of computer facilities for teaching in universities. It would be desirable if some of that money was allocated to develop the use of computers in teaching environmental science.

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THE SYSTEMS APPROACH AS AN INTEGRATING CONCEPT IN THE TEACHING OF ENVIRONMENT

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This paper sets out to discuss and evaluate a first year undergraduate course entitled 'The Natural Environment', developed over a period of ten years by the author and two former colleagues. The course developed initially in an era of expansion and innovation under validation from CNAA in a developing polytechnic. It integrates material from various disciplines and presents the environment in a unified and monistic manner, viewing it from the viewpoint of General Systems Theory. Various advantages accrue from this, and these will be discussed subsequently.

At the outset it should be stated that the environment is approached from the viewpoint of the physical geographer. The course was developed by three tutors - a biogeographer, a geomorphologist, and a climatologist, whose training lay in geography, and who were to teach the course in a department of geography. The physical geographers view of environment encompasses (not in any order of significance) geomorphology, climatology, and biogeography and soils, in other words the natural physical chemical and biotic components excluding the works of Man. This contrasts with views of the environment which incorporate man-made structures - the human environment. In the definition adopted here, the environment is considered as the habitat of Man, a resource within which human activity takes place, and which is therefore subject to modification by human agency. It is an essential corollary of this viewpoint that the operation of environmental systems must be understood in order to evaluate the impact of human activity upon them. It is argued here that a systems approach to environment better facilitates such an understanding.

It is recognised that there may be other entirely legitimate views, both broader and narrower, of environment within other academic disciplines. We are concerned here, however, with environmental education within the institutional context of existing disciplines. As matters currently stand, the subject matter with which we are here concerned is located mainly within degree programmes bearing titles such as biology, geography or environmental science. Table 1 attempts to indicate the relative contribution of these different disciplines to environmental education at this level in Britain. It is recognised that the figures for the public sector are very much an approximation, and are likely to be an underestimate on two counts. First, they include only courses validated by CNAA, to the exclusion of university validated courses for which data are difficult to locate. Secondly, it is probable that a significant amount of environment teaching takes place under the aegis of combined subjects degree schemes, for which data on the detailed breakdown of individual

Table 1

Student places (1982 intake) on environmentally related undergraduate degree programmes in the U.K.

	Univ.	CNAA	Total
Geography	1990	719	2709
Biology	1994	1102	3096
Environmental Science	353	316	669
Total	4337	2137	6474

subjects are not readily available. It is recognised also that within the programme titles of geography and biology, there may be significant variations in the relative weight given to material that might be regarded within this forum as environmental. The spectrum within geography ranges from the exclusively physical to the exclusively human; that within biology from ecology to biochemistry. Nevertheless and bearing these reservations in mind, the observation that I should like to make is that on the basis of these data it appears that a very significant proportion (> 40%) of teaching relating to environment lies within degree programmes in geography. Geographers are, therefore, making a very significant contribution to environmental education in terms of quantity, and it follows from this that the approach of geographers to environmental education is worthy of attention within the present context.

In designing a course on environment for undergraduates in geography, factors which had to be taken into account include the purpose of the course, and the limitations imposed by the A level backgrounds of the students themselves. The purpose of such a course, at foundation level, is to provide an education in the nature of the environment. It is recognised that for the majority of prospective undergraduates the purpose of such a degree course is to provide an education for life, not, at this level, a training for prospective research students or for prospective environmental systems analysts (these latter objectives may be accommodated by further and more advanced training). Within this context the objectives are to promote an understanding of environment, and therefore, to foster a perception and awareness of environmental problems, to identify the role of Man as both exploiter and custodian of environment, and to propagate an environmental awareness. It is an essential corollary of these objectives that the linkages between the various environmental systms be identified, and that this in turn implies an integrative approach to the subject.

It must be recognised also that any attempt to integrate across the spectrum or environmental disciplines must take into account the limitations of the monodisciplinary backgrounds of students qualified with A levels. The majority of undregraduates in geography degree programmes possess an A level in geography, a tiny minority in environmental science. From experience a modest though increasing proportion have studied a science subject, though rarely mathematics, to A level. Against this background the task becomes twofold:-

i) to integrate the approach to environment across a wider than previously experienced by most students,

ii) to pitch the scientific explanation at a level within the compass of the students.

The design and evolution of the course took place with the objectives stated above, and against the background of the above constraints. In order to provide a uniformity of approach, and acknowledging the debt owed to the stimulus provided by Chorley & Kennedy (1971), a systems approach was adopted throughout, which in turn led to a number of perceived benefits. The course which evolved is illustrated in Table 2, and is more fully developed in White, Mottershead & Harrison (1984).

The gross structure falls into four sections, as follows:-

A. A Systems Framework

This introductory section is intended to outline in general terms a conceptual framework, and to introduce the student to the bases of scientific explanation which are subsequently to be employed. The nature of systems is defined, indicating the different types of system which exist, together with a notion of conceptualising the environment in systems terms. The application of the concept of thermodynamic systems to environmental systems is introduced. The idea of modelling systems at various levels of explanation - black box, grey box, white box, is presented. The basic concepts of science are also introduced. An explanation of fundamental forces and the nature of energy and work form a basis for the understanding of the dynamics of systems, and, in turn, environmental processes; the nature of matter and atomic structure provide a basis for the study of environmental materials.

B. A Systems Model : A Partial View

This section presents models of major environmental systems at the global scale, employing the concepts introduced in the first section. Thus four major global systems - atmospheric, crustal, biosphere and ecosphere, are identified, both emphasising the systems approach and adding factual substance to the concept. The sources and nature of the energy available to natural systems are identified and explained, as are the interrelationships between the systems themselves. The concept of circulation of materials - water, gases and elements - is introduced, and exemplified at both global and major system scale. In particular the notion of element cycling at the ecosystem scale is discussed, thereby introducing students to the physical and chemical bases of life, and to the structure of communities and their relationship with the inorganic environment.

C. Open System Model Refined : Environmental Systems

Having identified major systems and their mode of operation in the previous section, the course now focuses down on more specific systems at a greater level of detail. The main substantive material in the course is dealt with in this section at a scale with which the student is familiar, and can relate to his/her own experience. The material is dealt with under the major headings of atmospheric systems, denudation systms, and ecological systems. The systems

Table 2

'The Natural Environment', course outline.

A. A Systems Framework

- I. Systems, Man and Environment
  - 1. Why a systems approach?
  - 2. Matters, force and energy

B. A Systems Model : A Partial View

- II. The Planet Earth
  - 3. Energy relationships
- III. Global Systems
  - 4. The atmosphere
  - 5. The lithosphere
  - 6. The biosphere
  - 7. The ecosphere

C. Open System Model Refined : Environmental Systems

- IV. Atmospheric Systems
  - 8. The atmosphere and the Earth's surface
  - 9. Secondary and tertiary circulation systems
- V. Denudation Systems
  - 10. The catchment basin system
  - 11. The weathering system
  - 12. The slope system
  - 13. The fluvial system
  - 14. The glacial system
  - 15. Spatial variation in denudation systems
- VI. Ecological Systems
  - 16. The ecosystem
  - 17. The primary production system
  - 18. The grazing-predation system
  - 19. The detrital system
  - 20. The soil system

D. Systems and Change

- VII. The Natural World
  - 21. Change in evnironmental systems
  - 22. Change in physical systems
  - 23. Change in living systems
- VIII. Man's Impact
  - 24. Man's modification of environmental systems

viewpoint is consistently applied throughout, and explanation is achieved by using common scientific principles and laws. This uniformity of approach and explanation is intended to emphasise the unity of the environment as a whole.

D. Systems and Change

In this section notions of equilibrium and its observe, change, are discussed. Change in systems can be brought about both by natural processes and by the impact of human activity. The causes and consequences of different types of change are exemplified with reference to various types of system, e.g. climatic change, seral change. The course is concluded by a consideration of Man's modification of environmental systems, both deliberate and accidental. This is based on the premise that a full understanding of environmental systems and processes is essential before human use of environment can be satisfactorily understood and managed. Within the constraints of the course, this section is intended as no more than a pointer to directions for further study, which may be taken up elsewhere.

As outlined above, the course progresses beyond the traditional limits of courses in physical geography. It is a course on environment; it employs scientific explanation. It may therefore be viewed as a scientific course on environment. The authors would not claim it to be exhaustive in content, for there are necessarily omissions imposed by the constraints of time. The role of the oceans, and indeed Man, are capable of much greater attention than has been devoted to them. Nevertheless, it may be claimed that in its use of the systems viewpoint, the course does offer a comprehensive approach, and one which can be applied equally by the student in individual study of those areas of the subject,of necessity,scantily treated in the course itself.

It is argued that the course offers a number of advantages over the more traditional approaches hitherto utilised by geographers, and perhaps others. A selection of these advantages will now be discussed.

1. It forms a coherent and unifying philosophy as a basis for studying the physical and biotic environment.

This permits very different types of feature to be examined from the same viewpoint. Structurally similar models can be constructed to describe very different types of phenomena. Thus, at the global scale, the megasystems - the atmosphere, the Earth's crust, the realm of living creatures - can all be modelled as open systems. Similar types of model can be constructed to describe features at smaller scales. Thus a section of landscape (e.g. the drainage basic), a local ecosystem, or a climatic phenomenon (e.g. a cyclone) can be modelled using the same approach. In all of these systems there are energy sources, both inputs and outputs of energy, an internal circulation of materials, exchange of materials across the system boundary, and a range of internal processes. They are all very different kinds of phenomena, yet all can usefully be viewed within a similar structured context.

2. It permits integration across traditional discipline boundaries.

The systems approach has been progressively adopted by the various branches of physical geography, namely and in chronological order, biogeography, soil geography, climatology and geomorphology (Gregory, 1985). It is now possible to integrate across traditional boundaries within the subject, emphasising the unity of the physical environment. This integration focuses attention on the interactions at the boundaries between systems. Thus denudation processes are identified as an interaction between the atmospheric and crustal systems. similarly the subsystem of weathering represents the interaction between crustal materials and atmospheric materials and conditions. In this way systems can be defined which represent interactions between other systms of larger scale. Integration is possible not only between divisions within physical geography; by adopting a language and approach in common with other disciplines outside geography, links with other sciences are encouraged.

3. It permits a range of levels of explanation.

The hierarchy of systems which exists means that systems may be studied at scales ranging from the global to the local. In geomorphological systems, for example, the functional unit of study can range from the macro scale (continent) through the meso scale (e.g. the drainage basin, itself capable of definition at many scales) to the micro scale (the experimental plot). At each of these scales a similar conceptual framework can be adopted, and functional relationships (e.g. the water balance) presented in similar terms. At increasingly larger scales, the resolution of the information declines, and the level of explanation is necessarily more generalised. A further property of scale in systems is that larger scales tend to be more appropriate to synthetic studies, whilst the smaller scale lends itself more to the analytical.

4. It permits identification of interrelationships between components of the environment at all scales.

What are, for instance, the links between such disparate phenomena as a kingfisher, a developing thunder cloud, a breaking wave and a landslide? This notion is stated by Commoner (1972) as the first law of ecology that everything is connected to everything else. The notion of interconnection, however, is capable of extension beyond the limits of ecology. All components, both physical and biotic, are parts of systems; and these systems themselves are interrelated at a higher or broader level. The breaking wave and landslide are components of two subsystems of the denudation system. The thunder cloud is a component of the atmospheric system. The kingfisher is part of the ecosystem. These major systems are themselves interrelated by flows of energy and materials. All objects in the environment, then, have there particular place and function in the global system. In other words, no individual object or phenomenon can be effectively viewed in isolation from its surrounds.

5. It focuses attention on flows of energy and circulations of materials, and the implications that these have in terms of environmental processes and environmental resources.

It is a matter of basic definition that any process requires energy in order to operate. The attention to process necessitates a consideration of sources of energy, and pathways of energy flow. A seminal paper in this respect is that of Linton (1965). This draws attention to fundamental energy sources e.g. solar energy, and secondary sources in the form of denudational energy, and plant and animal biomass. It therefore helps define and explain the distinction between renewable and non-renewable energy resources. Similarly, circulations of materials ar identified, pointing out directions and rates of flow of materials through systems. These in turn have implications concerning the availability of materials as natural resources. Perhaps the most fundamental flow is that of water; the rate of passage of water through the environment is a measure both of the supply of this essential commodity and of its potential as a source of hydro power. More subtle but no less important in terms of day to day production is the existence of biogeochemical cycles, and their role in primary food production. less obvious again is the fact that many mineral resources represent abnormal geochemical concentrations in the form of stores of particular elements, or combinations of elements, which are the results of geochemical circulation processes operating over the geological timescale. All of these materials and processes are fundamental resources upon which human life on this planet depends. An understanding of the underlying processes which govern their distribution and availability is crucial to the survival of the human species, and this understanding is in turn encouraged by the adoption of the systems viewpoint.

6. It permits the identification of critical regulators of environmental systems, and thereby the controls, both deliberate and accidental, exerted by Man.

There exist within environmental systems (as in others) key variables which act as valves or regulators. These regulators influence the distribution and flow of both energy and mass through the system. The application of conscious intelligence at one of these regulators constitutes a control system, which may be either deliberate or accidental in its consequences. All Man/environment impacts involve control of some kind, occasionally beneficial but mostly otherwise. It is essential for future harmonious existence that controls are recognised, and operated in a beneficial manner. The systems approach aids recognition of controls, and thereby the prediction of the outcome of their operation. Two examples of cascading systems will suffice to illustrate this principle. In the drainage basic systems model, water passes through a sequence of stores and transfers. Regulators exist at many points - canopy interception, evapotranspiration, soil infiltration capacity, river channel storage capacity and others. Each of these regulators is readily modified by human actions. The systems approach identifies these regulators and points towards integrated drainage basin management schemes in which all the critical regulators are subject to beneficial human control. The ecosystem model draws attention to energy storage within, and transfer between, the different trophic levels. This enables the efficiency of different agricultural production systems to be identified and points the way toward more productive and effective agricultural resource management practices. This is an important message to be understood in a world of shrinking agricultural resources and expanding population.

In conclusion, this paper has attempt to identify some of the benefits to be gained from adopting a systems approach to the teaching of environment. The list presented here is by no means exclusive and doubtless other advantages could equally be argued. The foundation provided by the course in the understanding of environmental processes forms a basis for further study, in which the interaction of socio-economic systems with environmental systems may be examined. Thus the approach taken by Douglas (1983) to urban systems may be better appreciated, whilst the way is pointed towards Odum's (1983) use of the systems approach as a basis for mathematical modelling of complex Man/environment interactions at the national scale. Using approaches of this kind, the understanding gained of environmental systems can be utilised in a predictive manner to the benefit of more harmonious Man/environment relations.

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IMPROVED LEARNING OF COMPLEX, DYANMIC ENVIRONMENTAL SYSTEMS USING COMPUTER BASED INSTRUCTIONAL SIMULATION (CBIS)

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INTRODUCTION

By various factions in the educational arena, the microcomputer (micro) is touted as anything from indispensible to disruptive, from a new revolution akin to that caused by the invention of the printing press, to a revolution akin to that caused by the discovery of the skateboard. Notwithstanding the range and extremity of these viewpoints, the many benefits of micros are most frequently encountered in texts and articles. Indeed, one tends readily to get a feeling of déja vu reading any of the many such texts and articles. The bandwagon appears to have been well and truly leaped-upon and its sounds, or noise, can be heard and felt at every seat in our arena.

What seems to be lacking are critical evaluations of how the micro is being used. None of us, surely, can refute the potential of the micro, but what has been achieved so far? Are we on the road to realizing this potential? In the USA some researchers consider many of the uses to which micros are being put to be 'disquieting' and a disturbing number of micros are nothing more than expensive paperweights. The general decline in the microcomputer industry over the last year is a reflection of a backlash against the micro, which in the field of education is fuelled mainly by a lack of effective software (Bork 1984). Although it is not the purpose of this paper to discuss the reasons for this situation regarding software, some background to computer assisted learning (CAL) will serve to place computer based instructional simulations (CBIS) into perspective. We might identify five major uses of micros in environmental sciences education (indeed, in education in general) : as a supercalculator, as a drill master, as a tutor, as a game show host and as a simulator.

THE MICRO AS SUPERCALCULATOR

Expert systems and rudimentary artificial intelligence (AI) apart, the computer remains essentially nothing more than a humble adding machine. However, just as the computer has opened up research avenues simply by its calculating abilities, so it can enable things to be calculated by students in order to get fast and reliable (generally!) answers in problem solving and drill and practice. Whilst this is obviously useful and to be encouraged, it is not really involving the computer intrinsically in the education of the student regarding the subject matter or fundamental skills.

THE MICRO AS DRILL MASTER

Anyone with even a rudimentary knowledge of BASIC can quickly devise a drill and practice program. These generally take the form of presenting some information, maybe running an example and assessing student comprehension through true/false or multiple choice questioning. Interaction is reduced to number selection and 'return' pressing and generally students do not find this kind of program very stimulating.

Drill and practice may have application in certain fields of training, but, in my opinion, are not relevant to higher education. The 'exercise' is often differentiated from 'real problem' solving but the latter is mainly held to be infinitely superior to the former, and often stressed at length in the environmental sciences (e.g. Peacock 1981). Most drill and practice bears little relationship to real problems. A further problem with drill and practice is that, at least for the foreseeable future, the computer is remarkably poor at parsing information. This has restricted computer based drills to true-false simplicity and multiple choice ludicrosity. Even the best of the current expert-system style drills are very poor substitutes for the human ear, although of course much less easily exhausted!

THE MICRO AS TUTOR

In the 1984 book 'The Art and Craft of Teaching' from the Harvard University Press (Gullette 1984), the three main components of the 'pedagogical continuum' are identified as the lecture, the laboratory and the discussion (tutorial). Computer assisted learning tutorials generally present information, and may be linked with drill and practice sessions. Presenting information seem much more akin to a lecture than a tutorial. Indeed, CAL tutorials generally provide little interaction with the students beyond pressing 'return', and certainly do not provide for tangential discussion, free-form thinking and expanded horizons which are the very aim of tutorials in the traditional form.

At best then, these programs are lecture replacements or adjuncts. But how inferior they are to a real lecture. Computers provide no eye to eye contact, no sense of flow and generally are totally uninspiring. Perhaps their only advantage is that the student may review material *ad nauseam* and at any time. Of course this means he isn't doing something else of equal or greater importance which hitherto he would have done, such as reading in the library or discussing Kant over coffee. Furthermore, recent surveys in the USA have discovered that both reading speed and comprehension are significantly lower from a computer screen than from the good old book, which, by the way, is portable, cheap, inexhaustably reviewable and much more attractive.

There is currently no proof that CAL tutorials or CAL drills improve student learning or problem solving skills. In addition, the majority of these programs that are available have been written by one or two authors within a specific course in mind. The result is a program that is really only effective in that course taught by those instructors, and suffers from being of only limited applicability elsewhere. To top it all, these programs are produced at great cost or sacrifice by the individual (normally the latter) and are always cost ineffective. Commercially developed software presents a similar straightjacket to instructors.

THE MICRO AS GAME SHOW HOST

Because the difference between game and simulation is ill-defined (Walford 1981) and generally we consider games as inapplicable or higher education, I will skip over this category with nothing more than a passing comment that games imply unreal situations and this would appear to work against our general drift towards 'real problems'. It is all too easy to focus on games that have 'little or no educational merit' (Bork 1984).

THE MICRO AS SIMULATOR

Imagine a program called 'flight lecture'. You plug it into you Acorn or IBM and sit through an hour of text and multiple choice questions on how to fly a light aircraft. Flight simulator is one of the most popular and impressive programs available for micros. Students cannot wait to use it, spend hours using it and gain educational experiences similar to those gained in a laboratory. Further, especially with a teacher present, such a simulator acts as a focus of discussion (tutorial). The oral lecture remains an integral part of the pedagogical continuum, and real experiences (real laboratories) can never be totally eliminated, but the simulation holds tremendous promise as an educational tool to allow us to do things we could never do before. To my knowledge such programs are currently not available in the environmental sciences.

AN EXAMPLE OF CURRENTLY AVAILABLE SOFTWARE IN THE ENVIRONMENTAL SCIENCES

To illustrate the points just made regarding currently available software let's look at an example; Moisture in the Atmosphere, released by IBM. It is sold in the USA for sixth formers through to undergraduate levels.

After reading the title page (again!) and choosing screen colours, Moisture in the Atmosphere (MinA) presents a main menu (called program menu) which allows the user the following further choices:

1 = Humidity, Fog, Frost and Dew
2 = Clouds and Precipitation
3 = True or False Quiz
4 = Matching Quiz
5 = Stop

On entering a number and pressing return the chosen program is loaded and run.

Humidity, fog, frost and dew continues with instructions which may be read and presents the 'tutorial' menu, which allows one to start at the beginning or enter the program at various key points. In any case, after making a choice and pressing return more information appears on the screen for the edification of the user. This includes graphics where molecules may be furtively bouncing around as more text explains what is going on. After numerous such screens, explaining humidity, fog, frost and dew in much the same way as text books do, one falls off the end of the program and is returned to the main menu as shown above.

Clouds and precipitation follows a similar format, 'explaining' such well understood and simple concepts as the Bergeron process, adiabatic cooling and the relationship between temperature and vapour pressure in series of screens with text and graphics. This culminates in descriptions of frontal, convectional and orographic precipitation before returning to the main menu.

After absorbing all this information the user now embarks upon either a true/false quiz or a matching quiz, or both. Both these programs interact with the user by requiring the pressing of T, F, return or a number from 1 to 10. These keys effectively do little but pass control to the BASIC program which selects from a range of pre-set pathways. At the very end the program tells you how badly you have done on the quiz. This may instill you to review the program.

What is this program trying to achieve? It seems to be trying to present information and test comprehension. What advantages does it have over a book? First, it has animated graphics, albeit rudimentary, and second the student cannot cheat on the questions quite as easily. These seem to be rather niggardly improvements and the overall worth of the program is in serious doubt considering the obvious advantages of books. Surely the micro can be used for more than just teaching vocabulary?

Such programs as Moisture in the Atmosphere may be reasonable applications of the micro in certain fields such as English, Mathematics or Accountancy, but in my opinion are particularly ill-suited to the environmental sciences. Environmental systems are dynamic, often massive and intangible, complex and remote. Particularly important is their dynamism, and the fact that our understanding of these systems is far from perfect. Thus, open-ended simulations which allow for exploration, rather than present information, would seem much better suited to environmental sciences education. Moisture in the Atmosphere is no more than an expensive (both in terms of the hardware and software overhead) page turner and slide viewer. It is only mindlessly interactive requiring nothing more than return pressing and menu selection.

A SHIFT IN EMPHASIS

Our experience clearly showed that the great majority of attempts to teach environmental sciences using CAL have used the micro as nothing more than an extension of traditional teaching methods. Text (as in books), static diagrams (as in books), animated graphics (as in films) or question/answer (as in tests and quizzes) are prevalent among CAL tutorials, games and drills. Unfortunately, computer text is less effective than books, computer diagrams are much less detailed or clear than in books, animated computer graphics look ridiculous compared to films and question/answer can be performed more effectively off computers. At the Environmental Simulations Laboratory (ESL) we agreed upon a general rule, named after our head programmer, Tim Larson. Larson's rule states:

> Never do anything with a computer that you can do equally well without.

We became obsessed with designing CAL that would not transgress this rule, that would harness the power of the micro by employing its unique qualities. Specifically we wanted to create programs that allowed the user fully to interact with the environmental system under scructiny by posing 'what-if' questions. We see what-if questioning as the fundamental learning process.

The end result of our observations on currently available CAL in the environmental sciences was the concept of CBIS. I will expound on the various goals of CBIS later, but the definition states the overall objective:

> CBIS should present the user with the environment and tools necessary for the instructive exploration of complex systems. This exploration can be guided by offline materials or by an instructor but remains open-ended. The simulation should respond with realistic and instructive feedback such that the student learns by discovery, or 'by doing'.

This kind of use of the micro for simulation is relatively new. Strategic simulations, open-ended simulations for biology students which emphasise the scientific method, were introduced in 1982 (Jungck 1982) and simulated laboratories, specifically for veterinary science, became available in 1984 (Peterson 1984). Within geography simple gaming/simulations have been around since the late 1960's and similar examples to Jungck's are documented (e.g. Peacock 1981). With slight changes in emphasis, these uses of the micro as simulator share a common philosophy - to take advantage of the unique qualities of the micro to help students learn in a way they have never been able to before. They also all provide for a new approach to learning which Jungck (1982) terms 'post-Socratic'. Neither the student nor the teacher knows the 'answer' (this is particularly true in most branches of environmental science) and both are free to test hypotheses and heuristics as they grope toward pattern and theory. All these simulations do is provide the environment and tools with which to grope, together with realistic feedback from which to learn.

Within this general framework for CBIS 12 goals can be identified which are here described in no particular order:

1. Graphic: Relegate text to a more appropriate medium such as paper and include on the screen only that text which is essential to operate the program and present meaningful feedback.

2. Easy to Use: Use menus (preferably 'pop-up' style), a minimum of keys to operate the program, reduce the 'knowledge overhead' to a minimum and produce a self explanatory program so that the manual of procedure is as small as can be.

3. Fun to Use: Never force the user to do anything, allow them maximum control over the program and provide rapid and effective feedback.

4. Interactive: Interactive does not mean engaging the fingers, it means engaging the brain. A good interactive program may only require a modicum of key presses but keep the student thinking for extended periods of time.

5. Hands On: As far as possible make the simulation a replacement for field or laboratory work and allow the user to fiddle with the system under scrutiny.

6. 'What-If': Allow the student to ask the questions and seek the answers. 'The special quality of individual research lies in the motivation that results form raising one's own question. No question from another source will do so well. The limitation to any benefit in 'problem solving' [drill and practice] and in 'teaching machines' [tutorials] is that the student did not frame the problem'. Drill and practice and tutorials thus "... deprive the student of exploration and decision-making at a critical stage in his career". (Adolf 1968, words in brackets mine).

7. Open-Ended: This is one of the keys to the use of the micro's unique abilities. Instead of providing set pathways as in current CAL, CBIS provides a whole field with no obvious boundaries. The user is not only free to explore at will, but finds that in all directions there are no restrictions to what he can do. Indeed, even the boundaries of reality should not restrict a CBIS which may extend a physical law or system relationship to the limit. An example is SUNPATH, a CBIS under development at ESL. SUNPATH need not assume a 23.5 degree tilt in the axis of the Earth and thereby provide for exploration of Earth-Sun relationship well beyond anything currently dealt with in texts.

8. Self-Paced: Another facet of learner control is to let the student use the program at his or her own rate.

9. Condensed Experience: "... whenever research process and attitude are learned by experience, that is education par excellence". (Jungck 1982) Because of its speed and flexibility a CBIS can provide a user a wealth of experience of an environmental system in a matter of minutes.

10. Adjunct: CBIS should be an adjunct to a course and not replace other traditional parts of the curriculum such as lectures for which it is ill-suited.

11. Adoptable: Make sure the program not only does what instructors want it to do but also never forces the instructor to do things he or she does not want to do.

THE RESULTS

So far ESL has released, on a pre-release basis, three CBISs: GRAVITY, a gravity anomaly modelling program; WATERBUD, a Thornthwaite water budget analysis program; RUNMOD, a digital runoff modelling simulation. In addition, a further six programs are currently being prepared for distribution in a similar fashion: INPUTOUTPUT, QUAKE, SUNPATH, GROUNDWATER, FLUVIAL and AIRLAB. AIRLAB and MinA would appear to have similar goals and share the same subject matter. Their comparison best illustrates the differences between CBIS and current CAL. It is not possible to describe AIRLAB like MinA because it does not have a set pattern and each time it is used it presents unique results; it really has to be experienced. However, a general description serves to highlight the major differences. AIRLAB simulates a well-equipped laboratory where students experiment with the humidity of the atmosphere. With AIRLAB, students learn fundamental concepts and recreate graphs and tables presented in standard physical geography and environmental science texts to more fully understand their significance. The experiments are:

1. Temperature-Vapour Pressure Relations
2. Operation of a Psychrometer
3. Adiabatic Lapse Rates/Atmospheric Stability

AIRLAB is animated, with numerous digital and analogue readouts. These represent the dials and strip charts that record the progress of an experiment. Thus, the student is free to ask a question, design and experiment, and record the results. From the results, he or she can identify pattern and generate theory regarding atmospheric dynamics.

AIRLAB's simulations are based on standard equations for saturation vapor pressure, wet bulb depression, atmospheric pressure and dry and saturated adiabatic lapse rates.

THE CONCLUSIONS

1. The microcomputer will never have any fundamental effect on the quality of learning of environmental science students until we abandon using it as a drill-master and start to use if as a window through which students may interact with simulated environmental systems. Let us begin to design CBISs that allow students to learn through 'research as self-education' (Adolf 1968), to learn by doing, to learn by asking questions, to learn how to ask questions.

2. It is often held that 'open-endedness' is ill suited to the 'average student' who expects information to be presented or given. This is pure poppycock, distributed by the 'educationalists' as part of a rationale for their own existance. All of us ask questions, all of us investigate our environment from the moment of birth - we cannot help it, we are all addicted. Adolf is right, no matter what we do in life, we are all researchers of one sort or another. If the 'average student' expects information to be presented, to be learned rote and regurgitated at exams, it is because we have taught him to expect it!! Obsessed with teaching, teaching method and educational theory, we have forgotten learning (Naiman 1985). Current CAL teaches students. CBIS is designed much more humbly, simply to allow students to learn more, and more easily. CBISs teach nothing. An IBM running a CBIS should be Socrates personified!! Most CAL is designed to provide fish, CBIS is a rod with which to catch ones' own fish.

3. "Avoid compulsion and let your children's lessons take the form of play". Plato.

AVAILABILITY

All ESL CBISs will eventually be made available commercially. In the interim, copies of finished programs with manuals are available direct from ESL in a pre-release format. The major aim of the pre-release is to obtain feedback from the users for program refinement prior to commercial release.

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FIELDWORK SKILLS -
THE POTENTIAL OF FOREIGN ENVIRONMENTS

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INTRODUCTION

The range of interests and of background disciplines of those concerned with environmental education is quite vast. This does have an advantage in the exchange of ideas and the refreshing effect of different attitudes and perspectives but it may also mean an equivalent range of perceptions of the importance of particular environmental issues, of the methods and practices of 'other environmentalists' and even of the meaning of quite common terms. It is to avoid some of the difficulties which might arise from these different perceptions that some potential misunderstandings about 'geographers' and the term 'fieldwork' must be tackled at the outset.

To belittle the geographer and to exaggerate the possible misunderstandings of his fieldwork methods and contribution, one might suggest that data collection for its own sake characterises most fieldwork exercises and that the success of fieldwork is measured according to how wet one gets. This silliness raises two important points:

1. the principal concern of the geographer in his fieldwork is not with the physical environment per se but relates to the human habitat. This wider concern requires a different set of fieldwork techniques and a different approach to be developed from those used in a purely physical context,

2. the main function of the geographer in higher education is not to communicate the purely mechanical skills of data collection but to develop skills in a problem-solving context.

The acquisition of data is a valid exercise only in a programme of fieldwork if it is implemented within an appropriate and effective context. It is this requirement which challenges the geographer to be more complete in the development and teaching of fieldwork and to resist an over-emphasis on the technical aspects. It's a sort of 'package deal' which is needed.

This paper aims to identify the more appropriate forms of fieldwork in a foreign environment and to reaffirm the need for effective fieldwork in the various subject areas of human geography.

FIELDWORK IN A FOREIGN ENVIRONMENT

The potential benefits and the difficulties of an integrated approach to fieldwork are illustrated most effectively in a foreign environment - any area with which a student is unfamiliar could be regarded as foreign but, in this discussion, the term refers to fieldwork in another country.

A foreign environment for fieldwork may be daunting. The cost may appear prohibitive; language may appear to present insurmountable problems; the distance may appear to present the final inconvenience and provide a strong case in any argument about doing similar fieldwork 'nearer to home'. On the contrary, the rewards of foreign fieldwork are enormous. The cumulative effects of working within a different cultural and political context, of handling problems which are apparently the same but are perceived and tackled in quite different ways and of the challenge to a student to adjust his 'stance' produce subtle and valuable benefits. There is a quiet but important realisation during fieldwork in the Netherlands that it is not "all clogs and tulips"!

CATEGORIES OF FIELDWORK

Broadly speaking, it is possible to separate the types and functions of fieldwork into three categories:-

a) Research procedures

This type of work is intended to develop the student's ability to design a research project and to follow its evolution as well as to teach quite specific techniques of measurement or analysis in the field.

To be effective the student should be involved in or aware of the several stages of the work from the initial problem identification, through the specification of data needs, project design, data collection and analysis to the final conclusions and recommendations. Clearly, a number of constraints are likely to prevent a student from being responsible for or even closely involved with all of these stages but to extract any of these stages for convenience or simplicity will risk isolating one part of the research procedure and producing a sense of bewilderment or even frustration on the part of the student. Particularly, it is the data collection aspect which is a tempting but unfortunate choice, apparently making a useful fieldwork exercise because it teaches measurement skills and survey techniques but, with a proper understanding of the research context, without involvement in the decisions leading to the specification of data needs or in the eventual output from analysis of the data, the students have only a glimpse of the total product, and so may conclude in addition that they are merely cheap labour and, indeed, are misled.

Some of the constraints which produce these difficulties are most easily avoided by enabling a student to be more involved with the research project not only during but also prior to a period of fieldwork. This requires, of course, far more careful design of the fieldwork programme and of the whole teaching programme but has the additional advantage that fieldwork becomes part of the syllabus instead of being considered isolated, or a diversion, or an irrelevance.

b) Problem situations

A full appreciation of the different facets of most environmental issues is unlikely to be gained by discussion at a distance. Contact in the field through an immersion in problem situations can achieve a closer and far deeper understanding of what is being tackled.

The possible look-see label for this type of fieldwork must not be allowed to discredit or patronise its worth because it requires the careful development of a student's ability to observe relevant evidence in the environment and must overcome the impression of looking at anything and everything. An interpretation with an on behalf of the student can be achieved in many foreign situations only by a field-based tutorial with a small group rather than a class whereby a discussion of the complex of visible components in the landscape/townscape can be given its proper economic, social and cultural context and nominated environmental issues can be developed through this discussion on site.

c) Contact with 'practitioners'

The valuable experience of those in immediate working contact with environmental problems makes it imperative that students are given the opportunity, whenever possible, to question and to challenge those in practice. The benefits are visible!

It is the balanced combination of these three categories of fieldwork which should form the basis of a fieldwork programme.

DESIGN OF A FIELDWORK PROGRAMME

Fieldwork programmes are easily inherited. The location, the allocation of time, the staff membership, all may go unquestioned as each fieldwork period passes without serious hitches. It is, however to the benefit of both the teaching staff and the student group to question fieldwork closely and to adhere to a number of principles of programme design:

a) Aims - a clear statement of the aims and intended achievements of the fieldwork programme as a whole. It should be a concise response to any 'what's the point of it all?' enquiry!

b) Framework - an outline of the structure of the fieldwork programme which enables it to be self-standing as an integrated field course and to be course-related in its links with and contribution to the main syllabus.

c) Content - detailed formation of each element of the broader framework and constituing a 'diary of events'. Where possible this should include a degree of choice enabling pathways through the fieldcourse as well as the compulsory sections and should provide a balanced combination of the three fieldwork categories.

d) Evaluation and assessment - perhaps fieldwork should be seen as sufficiently fundamental to be a reward in itself but without some more formal assessment of student performance fieldwork may become further isolated in the student's mind and perceived to be of less importance than the main syllabus. The programme should include, therefore, an explanation of the student's commitments, of the types of assessment and their relative weightings.

An element of evaluation of the fieldwork programme itself is, of course, achieved via the quality of the students' assessed work, but a formally scheduled session at the conclusion of the fieldwork programme to enable a 'run-down' discussion, to re-emphasise important aspects of the field-course and to invite constructive criticism performs an integrative function and provides useful feedback.

GROUP PROJECTS IN A FIELDWORK PROGRAMME

To develop the research procedures aspect of fieldwork, an emphasis upon group project work has enormous potential but it requires very careful management. Particularly crucial is the preparation phase, part of which must be prior to the fieldwork period to enable the students to 'key in' to their brief and to allow maximum utilisation of the limited field-course time. A number of principles emerge which are helpful in the management and operation of group project fieldwork.

1. Selection of an appropriate topic
   The topic must be appropriate to the main syllabus and to the fieldwork location but presents the difficult problem of needing to be realistic without becoming superficial. However, the use of groups to complement each other rather than to duplicate the same project brief can, if carefully designed, extend both the range and the depth of work.

2. Pre-field course workshops
   These workshops enable time-consuming aspects of the projects to be introduced and developed without impinging on valuable

fieldcourse time: initial presentation of the problem context; the project brief; the formation of project groups; the initial stages of project design by each group working within the constraints of the initial brief. The output from these workshops consists primarily of a separate draft research procedure for each group which includes a more precise problem identification, a framework for the exploration of the problem, the specification of data needs and an outline schedule for the implementation of the project. It is important to stress that this output is the result of a committee-based procedure and that staff involvement is deliberately minimised to be quietly advisory and to avoid instruction. Even correction of some of the potentially disastrous decisions may be postponed until the group have had the opportunity of 'self-correction' during the actual fieldcourse.

EXAMPLE GROUP PROJECT : THE POTENTIAL FOR TOURIST DEVELOPMENT IN VAL D'HÉRENS, VALAIS

Workshop

a) Consider and specify the type of tourist development which may be relevant within this Alpine environment.

b) Develop a framework of criteria to evaluate tourist development potential in general.

c) Consider the relevance of this framework to each specified type of tourist development.

d) Design a data requirement inventory for each specified type of tourist development in relation to the relevant criteria of the tourist development potential framework.

Types of tourist development	Tourist developments potential criteria	Data requirements

e) Devise an initial programme of work which will enable the potential for specified types of tourist development in Val d'Hérens to be identified (i.e. allocation of data collection tasks, labour, time, areas, etc).

3. Project implementation

a) Adjustment to the project design - a new student perception of the problem is almost inevitable when the group is actually 'on-site' and a final meeting of each group to confirm or to adjust the project intentions is essential.

b) Allocation of tasks - an optimum group size of four could provide a labour force of four individuals and so achieve a larger data set by dividing their labour. However, the continual exchange of ideas within a working pair, the moral and social support of a partner in a project and the extremely important but easily forgotten safety requirements make pairs the best unit even if data is being sacrificed. The interest and the new possibilities generated within the pairs and the gradually emerging coherence of each group as a decision-making team achieve what is impossible with individual or large audience fieldwork.

c) Group reports - each group is required to collate their findings and to formulate policy recommendations (where appropriate to the project brief). A nominated spokesman for each group presents a report to all of the groups providing the opportunity for questions, discussion and an evaluation of the project exercise.

d) Project assessment - each individual is required to submit a project report under a specified title to achieve an integrated view of the group's work rather than merely his own contribution and to avoid some of the injustices which may attend the assessment of group work.

The problem context for group project work overcomes the risk of providing mechanical and seemingly pointless tasks where the aim of the fieldwork has emphasised a specific technique and, at the same time, avoids the obsession for collecting data almost for its own sake. However, expectations of students who instantly and collectively 'see the light' are frustrated as the more open and more complex nature of an emerging project produces a proportion of the student group who fail to benefit as intended and may even be deemed to have 'missed the point'.

CONCLUSION

It is the plethora of descriptive, factual detail as a context for fieldwork which should be resisted if there is to be a development of skills and expertise in the study of the environment and, particularly more guidance for the student is required in a foreign environment if the full potential of fieldwork is to be realised and the risk of apparently vacuous tasks avoided. This makes an explicit statement of the aims of fieldwork essential if an integrated and balanced programme of work is to be achieved.

Resource constraints are serious and the 'value for money' requirement for fieldwork is legitimate. Fieldwork in a foreign environment is the most obvious target for any cost-cutting exercise and is not easily defended in any cost-benefit debate. To withdraw from foreign environments as a saving would, of course, isolate the student and deny him a significant educational opportunity but only when fieldwork programmes are more explicit in their aims and achieve more demonstrable benefits can the offensive 'sightseeing' label be properly rejected.

THE ESTABLISHMENT AND SEQUENTIAL DEVELOPMENT OF COURSE AIMS FOR FIELD WORK IN ECOLOGY ON DEGREE AND DIPLOMA COURSES

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INTRODUCTION

There are several preconceptions about what should or should not be included in ecology field work. It is often counterproductive to pay undue attention to the detail of courses designed by others, as these are often designed to meet specific needs or to promote particular interests. In my view the opportunities for the development of field work studies are many and varied, however they should, whenever possible, reflect the interest and expertise of the staff who organise and implement the programme of work. In this way students can associate themselves with the enthusiasm shown by the staff, they may be free to develop their own particular line of interest and may gain a fuller understanding of the natural and man made environment. Students develop an interest in their subject in a variety of ways; some from earlier formal education, some from hobbies and some as armchair ecologists from the ABC of television biology (Attenborough, Bellamy and Cousteau). The role of courses in Higher Education should be to foster this interest and to provide the student with the necessary knowledge and skills to participate in future studies of the environment.

An important consideration in any field work programme in ecology is to provide the student with the necessary skills and abilities to take an active part in assessment and monitoring of the environment either alone or in conjunction with others. It is only by active involvement that a student will gain a fuller understanding of the environment and thus make a useful contribution to society in his chosen subject.

The purpose of this paper is to consider how to make the most of field work programmes through careful preparation and planning. By introducing a student to new skills and building on existing skills in a sequential manner the student may gain in confidence and maturity of thought and ultimately becomes capable of dealing with novel situations and drawing logical and well founded conclusions.

THE DESIGN OF COURSES

There are several guidelines which may be used in the preparation of a programme of studies for courses at degree and diploma level. Publications such as: The Council for National Academic Awards handbook of Policy and Regulations; The Business and Technician Education Council Programme Committee Guidelines and their publication Policy and Priorities in the 1990s. In addition, regular publications and meetings of the International Union for the Conservation of Nature, The Institute of Biology, The Institute of Environmental Sciences, The British Ecological Society and the Council for Environmental Education, provide valuable additional information.

To someone embarking on course design, the prospect of wading through such documents may seem a daunting task. Having undertaken the task one finds that although differences in emphasis may occur there are broad areas of agreement as to the aims of courses in Higher Education. These aims may be summarised as follows:

A course should encourage a student to:

1. Understand the scientific principles which form the basis of the subject.
2. Develop skills and promote intellectual development.
3. Retrieve, store and communicate scientific information.
4. Understand the relevance, use and limitations of mathematical modes of expression.
5. Be aware of the hazards of the work being undertaken and take appropriate precautions.
6. Develop logical arguments, develop imaginative skills and adopt a creative approach.
7. Synthesise information and propose and test hypothesis from incomplete information.
8. See relationships between learnt and actual situations.
9. Be aware of the relevance of the knowledge and skills obtained and how they may contribute to society.
10. Be aware of the possibilities for future study.

It is no doubt possible to identify aims not included in this list however the aims stated have been a useful checklist in the design of courses in Biology at Wolverhampton. These educational aims provide the framework for course design and they are applicable to theoretical, practical and field work programmes.

The main contention of this paper is that these aims are best implemented in a sequential manner rather than attempting to satisfy all aims at each stage of the course. An ecology programme which allows such development would be:

(a) An introduction to the environment.

(b) The development of analytical and observational skills.

(c) The habitat approach to the study of organisms in their environment.

(d) Assessment of natural populations and production.

(e) Environmental Assessment and Management.

This programme is based on an early introduction to general principles It is followed by the development of skills of observation, sampling, recording and presentation. Skills of species identification are developed and the distribution of organisms is related to physical, chemical and biological variables in the environment. Skills of analysis and numeracy are developed and these are incorporated into the design and implementation of sampling programmes. At this stage a more critical approach to the acquisition and interpretation of results from field and laboratory situations can be encouraged. Finally the students may draw on all these experiences to make reasoned judgements and predictions based on their own observations and these may be incorporated into environmental management or maintenance programmes.

Field work is used throughout this programme and it is possible to identify broad and specific aims for field exercises to complement theory and laboratory work. These aims should be defined beforehand with the broad aims designed to show how the field work programme would be developed while the specific aims provide the basis for organisations of individual field visits. The sequential development of these aims is shown in Table 1.

Just as the ecology programme relies on the gradual acquisition and improvement of skills all the field work components require careful planning to ensure that the student is adequately prepared to take full advantage of what may be a fairly short time in the field. Wherever possible they should also be given adequate time after a visit to draw together, interpret and reflect on what has been achieved. It is important that theory work and laboratory exercises are used in conjunction with the visits to make the most of these valuable excursions. If this is done carefully it is particularly rewarding to observe the effort and enthusiasm which students will exert to complete their reports.

PLANNING OF FIELD WORK

Planning of field work to meet the aims defined in Table 1 requires members of staff to prepare carefully for each visit. Any one field visit should not attempt to satisfy more than one broad aim but may satisfy more than one specific aim. One should, however, be wary of excessive use of any one specific aim. For each visit the programme of work should be defined, an itinerary should be prepared, the excursion should be fully provisioned and students should be informed of exactly what is expected of them. Failure to meet these requirements inevitably leads to confusion, lack of enthusiasm and loss of interest on the part of the student.

For field visits of the illustrative type staff should have a thorough knowledge of the site to be visited or use the services of specialist staff at the site. A 'Cook's Tour' approach should be avoided whenever possible. Requests to record certain items or carry out simple analysis will ensure that all students become actively involved, stragglers cannot claim to be unaware of what is required and students do not strain to hear what is being said in a howling gale.

Where evaluation is the main aim of the field work then staff may only require an outline knowledge of a site. They will however require a thorough knowledge of the analytical procedures used and their limitations. Here staff will tend to work with students in open ended exercises. Students should be made aware of the limitations of sampling methods, tests kits and various meters, while numbers displayed on calculators should not be given undue credibility.

In the later stages of a course where application becomes the main aim, the role of the member of staff changes again. Here it involves assisting the student in the planning and implementation of their field work. It involves assistance with the selection of appropriate methods or the refining of certain existing methods. Student should be encouraged to limit their objectives to obtain meaningful results within the time available. Constructive criticism becomes more important than formal tuition at this stage.

Within these guidelines field work will need to be planned in relation to the time available such as half-day, day, weekend or 1 week+.

Day or half day visits mean relatively short periods of time in the field particularly if an element of travel is involved. All the broad aims described previously can be achieved using these short field visits, however greater integration with theory and laboratory work is required where the main aim is evaluation or application. The following examples illustrate the different approaches required to satisfy different broad aims in field work of short duration:-

Where the broad aim is illustration relatively little preparation is required. A relatively simple exercise may be chosen to illustrate community structure. Students may be made familiar with the most common species found in an environment by a laboratory exercise and/or they may be given a simple key which will enable them to identify species in the field. During the visit students would be required to map the distribution of the major plan species or examine the distribution or diversity of animal species. Following the visit they would produce a short report of their findings.

If the broad aim is evaluation or interpretation then typically greater preparation is required. An example of such an exercise is the appraisal of a fresh water fishery in a pond or lake. Prior to the field visit students should be made familiar with the theoretical background. Appropriate reading will have been carried out, e.g. Bagenal (1978) as will laboratory exercises in fish identification, identification of fish parasites, methods of ageing of fish, methods of assessing fish population structure and production and factors affecting the distribution and survival of fish. Based on this information a sampling programme will be drawn up to be implemented on the day of the visit. Following the visit time is made available for collation and interpretation of data and the students are required to propose a management programme based on their results.

Day and half day visits may be used in sequence such that preliminary visits to sites may be used to identify problems while later visits may be used to investigate these problems in detail. This approach is most common in student project work.

Field Weeks and Field Weekends allow much greater scope for the development of field based studies. The academic advantages include a continuity of study the opportunity for flexibility so that particular points of interest may be followed, and of consolidation where techniques and skills may be rehearsed, tested and modified over a period of days. The social advantages of these visits should not be overlooked as they serve to improve staff/students relations, help the students to establish a course identity and generally serve to improve student morale. Although these excursions can be expensive the advantages from them are such that every effort should be made to include them in any field work programme.

If only one longer visit is included in a course then it is inappropriate to use the whole of the period to satisfy the broad aim of illustration. While illustration may be a spin off from the various exercises undertaken the time is best spent in the promotion of the aims of evaluation and application. If two or more longer visits are included in a course of study the sequential development proposed earlier can once again be implemented.

Selection of venues for longer field work is important. To satisfy the broad aims of illustration and evaluation the best results are obtained where there is a wide range of habitats accessible from the base. There should be a high species diversity and the area should be aesthetically pleasing. If these site requirements are met they will help to maintain the enthusiasm of the student group throughout the visit and act to counter the possible negative effects of continued bad weather, strange food and working for long hours. At these sites the great species diversity enables student to improve their skills of identification and classification. The wide range of habitats mean that different sites can be used to introduce a range of techniques of sampling, data recording, data collation, data analysis and presentation (e.g. as described in Lewis and Taylor, 1967, Wratten and Fry, 1980 and Brewer and McCann, 1982).

TABLE 1 Sequential Development of Aims in Ecology Field Work

BROAD AIMS	SPECIFIC AIMS
Illustration	(a) To gain first hand experience of general principles.
	(b) To observe diversity, community structue, adaptations.
	(c) To gather and record data.
	(d) To gain hands-on experience of analytical techniques.
Evaluation	(e) To promote team studies student/student and student/staff.
	(f) To establish and test hypotheses in autecological and community studies.
	(g) To apply analytical techniques.
Application	(h) To evaluation patterns of distribution.
	(i) To observe how others have applied knowledge and techniques.
	(j) To appreciate socio-economic implications.
	(k) To establish management and maintenance programmes.

If the broad aim of the field work is evaluation or application it is as well to select a site where the applied nature of the subject can be stressed and where learning can take place by student participation in problem solving in a meaningful setting. This could be achieved by selecting sites such as an estuary, a deciduous woodland or a freshwater system known to be subjected to pollution. In these environments it is possible to gain a detailed knowledge of the organisms present, to relate patterns of distribution to underlying processes, to examine feeding strategies, to design and operate techniques and generally to carry out open ended exercises. Students can be encouraged to carry out project work in small groups and produce reports based on reasoned judgements. They could also be required to comment on land use, conservation and resource evaluation and exploration.

SUMMARY

This paper lays out a set of guidelines which should be considered when planning field work in ecology. It is not intended to be a definitive document on course structure and content, or the design of project work as these aspects are the perogative of staff preparing their own course.

If shows how the definition of aims, thorough preparation, description of work programmes and analysis of outcome are essential in the development of field work programmes in higher education. Theory work, laboratory work and field work should be integrates so that knowledge and skills are developed in a logical and sequential manner so that students may gain in ability and confidence so that they may take an active part in improving our understanding of the environment in which we live.

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THE USE OF UPPER AIR DATA IN THE TEACHING OF ATMOSPHERIC ENVIRONMENT

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INTRODUCTION

The importance of the atmosphere and its operation to all aspects of the environment is brought sharply into focus whenever its behaviour varies from our normal range of expectation. Whether it is a snowbound Britain, a drought-stricken Sahel, or a flooded monsoon delta, both man and his environment are affected at all points by the atmospheric ocean encompassing the earth. All who are interested in the environment should therefore have more than a fleeting interest in the mechanisms by which the world's weather and climate are produced. Unfortunately, the study of meteorology and climatology tends to be regarded as almost mystically difficult by many, but this need not be so if suitable practical, visual means of teaching and learning are used. In my own work with undergraduates, the use of full tephigram is one means of bringing practical work, and an element of reality, into some of the major areas of theory.

BACKGROUND

i) The Course

The work discussed below is part of a subject area in a Combined Studies Honours degree course at Nene College of Higher Education, Northampton, England. The subject area, Earth Science, comprises geology, geomorphology, and meteorology/climatology, that is, the inorganic elements of the physical environment. Students may study it for three years as their main subject area, or for two years as a subsidiary subject. Occasionally, a student may take only the first year of the course. In each case, they will include aspects of all three elements of the subject. Students most commonly choose to study Earth Science in a combination of four or five related subjects which together comprise either an Environmental Sciences programme (with Environmental Biology, Geography, and various one year courses such as Fossils and Evolution), or as part of a package biassed more towards the Human Environment (e.g. with Geography, and Development Studies).

ii) The Students

As they have been accepted for a Combined Studies degree course which will include four or five subjects, there is no guarantee that all students will have the background knowledge in one's own subject which might be expected in single or joint honours students. In addition, I find that often, even amongst those who have studied meteorology in their Advanced level Geography course, students either had an absolute minimum to enable them to answer one question if necessary in the examination, or, if they had a more comprehensive course, it was poorly taught and understood. There are, of course, exceptions but my experience is that generally meteorology is poorly taught and leaves students with some very confused concepts on entering higher education.

iii) Personal

I have to confess, however, that even after my own undergraduate studies, my understanding of meteorology was often somewhat hazy, although memory helped to clear exam hurdles! The sharp clear light of the need to teach it to an Advanced Level Geography group however, made me realise that, as I cannot teach what I do not understand, I needed to do some work. I have therefore come the hard way, battling through my own problem areas and probably, therefore being more conscious of the conceptual and perceptual problems the students may be experiencing.

My initial post in Higher Education was to teach and have organisational responsibility for Environmental Studies in teacher training courses. As the college has developed and courses changed, I have found myself the meteorologist on the Earth Science teaching team, working with Combined Studies and teacher training undergraduates, and also with teachers on a range of in-service and other courses. Groups are generally small, informal and interactive.

THE TEPHIGRAM - INTRODUCTION TO THE TOOL

i) Field Data

Students in Earth Science have about twenty-four hours of meteorology in their first year. The time is organised in three hour blocks and is therefore flexible for lecture, practical, and seminar work. The emphasis in the first year is on 'Water in the Atmosphere' which includes atmospheric composition, stability, formation of precipitation, clouds, and visibility, with other topics as time permits.

In the first few weeks of their course, the first years have a weekend field course based at Losehill Hall, Castleton, Derbyshire. All three major elements of the subject use some of this field time. The meteorology component has two exercises: the students use pocket barometers to plot contours as they walk up the valley floor of Grindsbrook Clough above Edale, thus establishing the concept of fall in pressure with height. They then use this concept to determine fifty metre intervals to a height of two hundred metres up the valley sides from the stream, and take the air temperature at each level, with an additional wet bulb reading at the stream level.

This data is briefly discussed to establish the concept of an environmental lapse rate and is then retained for later work. The field measurement proves extremely valuable in later differentiation between environmental and adiabatic lapse rates - few forget the exertion of the climb!

The second lecture session deals with lapse rates and uses the field data as a practical exercise, incidentally demonstrating instrumentation problems and microclimatic variations. It is first plotted onto standard two millimetre graph paper, and a dry adiabatic lapse rate calculated and constructed from the surface temperature. The condensation level is then estimated from the wet bulb temperature and observation of cloud base at the time of reading. The stability or otherwise of the weather conditions experienced on the field course is briefly discussed and will be used in more detail in later lecture work on cloud types and precipitation. Students usually have to think carefully about the construction of the dry adiabatic lapse rate based on the field readings so, after a coffee break, the tephigram is introduced as an 'easier' way of handling the data because the axes are already drawn, including the adiabats.

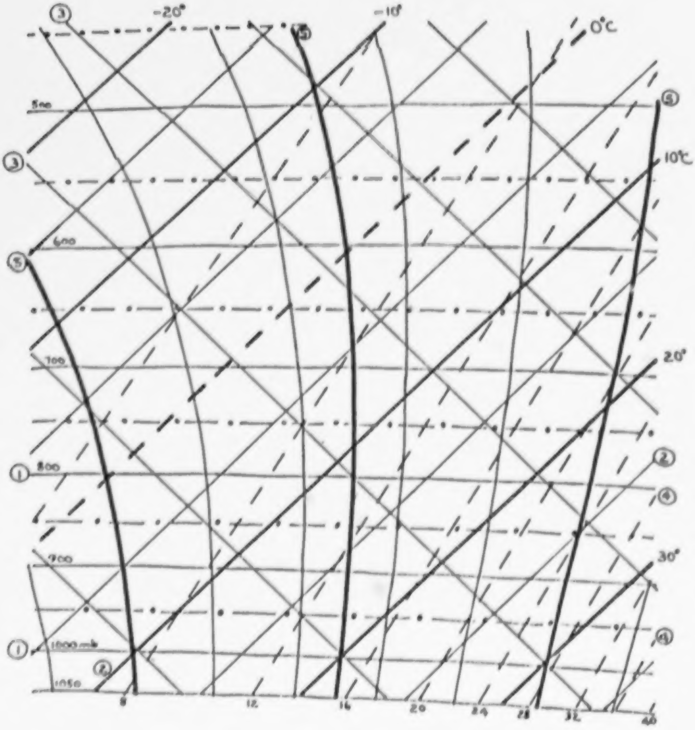
ii) The Tephigram

The tephigram is introduced by a sheet which explains each of the axes, and which has several sets of data for later practice. The pressure axis is introduced first, recalling concepts of vertical pressure changes in the atmosphere and noting units and intervals used. Next the temperature axis is located and again the units and intervals noted. Some degree of familiarity is then obtained by plotting a set of data (temperature and pressure) at fifty millibar intervals and the type of lapse rate thus plotted is agreed.

The third axis introduced is the dry adiabat, since this corresponds to the line constructed by the students on the standard graph paper. It can thus be seen as an aid to work and a number of short questions will be discussed about specific adiabatic temperature changes with height both upward and downward. A dry adiabatic lapse rate is drawn from the surface temperature and pressure previously plotted to illustrate its use from determining stability and to raise the question of finding condensation level in order to draw a saturated adiabatic lapse rate.

I have used both wet bulb temperatures and mixing ratios for this latter purpose, and find that understanding is easier if the mixing ratio is explained and used from the outset. Analogies of two-stroke mixture and pastry mixes, though weak, help here according to the interests of the group. It can then be demonstrated that the rising parcel of air with its water vapour content eventually reaches a combination of

FIGURE 1 TEPHIGRAM AXES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temperature and pressure levels at which the water vapour content is the maximum it can hold, i.e. where the dry adiabat intersects the mixing ratio line for the water vapour content. The fifth axis, the saturated adiabat, is then introduced and the full path curve obtained completes the picture for the moment. A number of environmental and path curves are then constructed from the exercise data to consolidate the technique.

USES OF THE TEPHIGRAM

Once the basic techniques of construction have been mastered, the tephigram is used throughout the course as a practical tool (as is the weather map) from work on cloud types in the first year to pollution plumes in the final year applied meteorology option.

By the end of the first year course, a student is expected to be able to construct and interpret environmental and path curves, to determine the humidity and stability characteristics of an air sample from its data, and the likelihood and level of stratiform or cumuliform cloud. This is not detailed forecasting and, in fact, assumes a constant mixing ratio with height. It is intended to develop a technique and understanding for using the tephigram to distinguish between air masses in later work.

Most of the second year course is synoptic in character, focussing initially on the British Isles, but with a contrasting study of either tropical or North American climates. A study of air masses and pressure systems, initially with reference to the British Isles, is followed by the dynamic climatology of the chosen region.

i) Cloud Study

Stratiform clouds are discussed as clouds which result from widespread cooling in the atmosphere, and the major cooling mechanisms are discussed from the tephigram curves constructed previously. The first cooling mechanism discussed is widespread lifting (orographic or frontal). It can be demonstrated on the tephigram that air lifted from the surface temperature and pressure will cool adiabatically until it reaches the condensation level previously constructed. This can then be identified as the lifting condensation level (L.C.L.) and the potential cloud base for stratiform cloud. The stability characteritsics of the air and the height of the potential cloud base then allow an informed judgement of the likelihood of stratiform cloud actually forming in the circumstances. Cooling by radiation can be considered by finding the amount of cooling (in degrees Celsius) required at any level for saturation to occur. This can also be used to indicate the likelihood of fog.

Cumuliform clouds introduce a new element since surface heating and convection are involved, thus the necessary path curve will not start at the given surface temperature and pressure. Students are asked to consider, from their experience, where else on the curves a condensation level could occur. Some are able, by deduction or intuition, to identify this second level. Others need further guidance but then realise that, again assuming a constant mixing ratio, the environmental air will also be saturated at the point where its curve intersects the mixing ratio. The problem then posed is how the surface air can reach that level. Again, some will deduce that the dry adiabat from that level back to the surface pressure will give the surface temperature necessary for a thermal to reach this second (convective) condensation level, or C.C.L. Although not strictly accurate, we use this required temperature at the surface pressure as a 'working definition' of potential temperature, since it allows the student to assess the probability of the surface air attaining that temperature in given conditions, and hence initiating cumuliform cloud. This is of particular importance in later air mass and pressure system studies. General stability conditions are then assessed for potential cloud development and depth, and possible precipitation.

ii) Air Mass Studies

Air mass studies, as already mentioned, are a foundational element of second year work. Their nature is introduced by the construction and analysis of environmental and path curves using data representative of the major air mass source regions (Arctic, Tropical maritime, Tropical continental). The analysis is used to reinforce and exemplify the concept of the stability of an air mass in its source region and the subsequent difficulties in reaching condensation level, other than by surface cooling in some cases e.g. desert dew. It also clarifies the distinctive nature of each air mass in its source region and provides a profile against which to consider variations.

Modification of air masses is studied with particular reference to the British Isles in the first instance. Examples of Polar maritime and Tropical maritime air over Britain are analysed on the tephigram and the nature of their associated cloud and precipitation predicted and discussed. The curves constructed from the British data are then compared with the relevant examples of air masses in their source regions and the modifications in character and associated weather noted. The study in relation to the British Isles is completed with the analysis of examples of the variety of air masses received from the modification of Arctic air. At each stage, the information drawn from the curve analysis is compared with synoptic charts of examples of particular air mass flows over the British Isles. Some appreciation of the range of variations from the 'norm' can thus be obtained.

iii) Pressure System Studies

The air mass work leads naturally to pressure systems, these being introduced as a further, and particular, type of modification of an air mass.

High pressure systems are therefore introduced as modifying either Polar or Tropical air by widespread subsidence. Upper air data for warm and cold anticyclones illustrate the similarities and differences compared with 'normal' Tropical and

Polar air over Britain respectively. Data for successive days can show the temperature and humidity changes produced by continued subsidence and the analysis is usually compared with surface weather reports and synoptic charts where possible.

Frontal low pressure systems are seen as the product of air mass convergence, modification, and interaction, in the context of upper air divergence on the limb of a Rossby wave. Thus ana- and kata-type fronts relate to previous studies of stability and modification of air masses.

iv) Other Regional Studies

The contrasting region studied in the second year is usually either North America or Africa. The former is an option because of the range of examples available to illustrate sample climates on a genetic basis of classification; the latter may be chosen if the group includes a large number of students who are also studying the second year Geography course which has a lecture course on Africa. Whichever region is studied in a particular year, the foundation work described above can be applied in a specific environmental context, and the student is encouraged to use past theory to deduce probable weather and climatic conditions. The nature and problems of a particular climatic type are discussed, including its interaction with, and implications for, the regional environment. The hot desert study thus evolves from previous work on Tropical continental air in its source region; polar region studies evolve from Arctic source region work, and so on. The character and variability of tropical precipitation is an important element of the work on African climate to give climatic background to economic and social studies of agriculture and drought in either the Geography or the Development Studies courses. Similarly, the polar region studies, if North America is chosen, provide a climatic background for geomorphological studies of periglacial phenomena. Both topics would also be carried forward into studies of climate change in the final year option in applied Meteorology and Climatology within the Earth Science course.

CONCLUSION

Although I found no one book adequate in the preparation of the work described, helpful material on the subject can be found in the books listed in the references. For students, however, the lecture/demonstration/discussion seems to be virtually irreplaceable at present for establishing the basic understanding and technique. The effort involved is rewarded by the ability of students to handle and analyse appropriate data, to deduce basic climatic conditions in a particular area, and to have some understanding of the interaction between the climate and other elements of the environment.

A useful source of upper air data for Britain is to be found in the Weather Log, published monthly with the journal 'Weather' by the royal Meteorological Society. Unfortunately, the data is for Crawley (S.E. England) only, so that allowances must be made for the land track over Britain, particular for Polar maritime and Arctic air masses. It would be helpful to have similar data available for a range of stations, possibly with synoptic charts such as those published by London Weather Centre.

However, with more data available, one might be tempted to become too strongly meteorological and lose sight of the environmental. At present, the course as described above, helps to train a student's mind and develop their reasoning power on the one hand, and enriches their understanding and appreciation of the total environment on the other. One hopes that this is therefore achieving some of the principal aims of higher education.

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THE ORIENTATION OF CLIMATOLOGY TEACHING IN ENVIRONMENTAL SCIENCE DEGREE COURSES AT STIRLING UNIVERSITY

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INTRODUCTION

Hartshorne (1959) in his 'Perspectives on the Nature of Geography' referred to climate as "... the sum of certain characteristics of the atmosphere which vary areally in significant relation to some other phenomena, that is, the term implies environment". Climatology teaching at secondary, and to a large extent tertiary, levels has tended to focus on the 'areal' aspects of the subject at global or regional scales. This has invariably been based on classifications which identify climates on the basis of statistical or synoptic similarity. In so doing, it has been necessary for teachers to incorporate an increasing amount of dynamic and synoptic climatology which cross the very loosely defined frontier with meteorology.

Along this road, students have encountered mathematical and physical concepts which have always been a major problem for traditional geographers who do not encounter such levels of scientific complexity in other aspects of their subject (Atkinson 1978). As Geography has moved away from a regional to a process orientation (Oliver 1967), the subject has become fragmented and students inadequately taught by staff unqualified in the basic sciences. From an educational point of view, 'areal' climatology can be on the one hand dull and descriptive and on the other so deeply entrenched in fluid dynamics and mathematics to be unintelligible to the average undergraduate.

Environmental Science, which developed as an academic discipline in the 1960's, was not, as many outside the subject believe, another word for Geography, but should have represented a wholly new perspective on the environment, incorporating the more complex concepts from physical, chemical biological and social sciences. Although some Environmental Science degrees have inherited the fragmentary and largely unhelpful geographical approaches, most have espoused a broadly based systems viewpoint. Subject areas within Environmental Science are thus seen not as sub-disciplines in their own right but as parts of a working machine. The implication is that students require much greater degrees of scientific understanding than are required in traditional Geography. The traditional 'areal' approaches to macro- and meso- climatology will no longer be appropriate.

The process orientation of most aspects of Environmental Science tends to focus on relatively small temporal and spatial scales. It is, therefore, more appropriate to study climatology at comparable scales. Terjung (1976) writes "Most of the climatic problems of importance to mankind occur at interfaces in the lower part of the planetary boundary layer where the characteristics of the air are strongly influenced by the properties of the Earth's surface".

This is not to deny that meso- and macro- scales of climatology are of importance. Atmospheric processes operate across a space-time continuum, not at discrete scalar levels. Clearly, the current discussions on the effect of carbon dioxide, dust, and acidity in the atmosphere are of paramount importance to the future of global environments. However, such discussions could perhaps be better understood when considered in terms of effect on processes within the biosphere, rather than as theoretical abstractions.

Environmental education can be seen as a formalising of a student's environmental experiences. This fund of experience can be placed alongside textbook theory to produce a solid foundation for informed, and not emotive, environmental decision making. The human senses accumulate a vast amount of information on environmental processes, mainly at relatively small spatial scales. The average student is unlikely to be aware of the current state of the Jet Stream in the upper atmosphere, but has immediate experience of, for example, blustery airflow conditions around buildings, or the moist calm conditions of a forest.

The most effective education is one which has an experiment element within it, which for want of a better term, makes the subject come alive. Unwin (1978) in referring to projects on urban climatology, says that ".... educationally they have the advantage of making climatology live through the medium of essentially local fieldwork, and showing why and how measurements are made. At the same time it should be possible to use them as a vehicle for classroom work in the rational explanation of atmospheric processes". Macro- and meso- climatic study does not readily provide opportunities for data collection and analysis, tending to rely on published pre-packaged data. This, in effect, creates a gap between what the student is learning and the 'real' environment in which he lives and works.

Teaching programmes which are based on small scale climatic processes are, therefore, the most appropriate to Environmental Science. Boundary layer climatology provides an opportunity for the development of programmes which integrate instrumentation, sampling, analysis and testing of hypotheses with lecture theatre and library learning.

ENVIRONMENTAL SCIENCE AT STIRLING

Stirling University offers a degree programme wholly within the Department of Environmental Science in addition to joint degree programmes, principal amongst which are those with Biology. Courses are usually assessed on a 50/50 division between laboratory reports and a written examination. The entrance qualification for all Environmental Science programmes requires at least one science Advanced or Higher level. In the current first year Environmental

Science course (1984/85) 86 per cent of English students have two or more science 'A' levels and 38 per cent have three. Of the Scottish students, 94 per cent have three or more Highers in science and 43 per cent have four or more. Not all these students are registered for honours degrees in Environmental Science. Those who are registered are expected to have studied physics and chemistry beyond 'O' level/grade. Where this is not the case they normally take specially designed courses in the principles of physics (mainly classical physics) and/or chemistry for the life sciences.

Climatology teaching is based on the loosely defined 'boundary layer' which embraces the lowest layers of the atmosphere and terrestial surfaces and sub-surfaces. Programmes are organised around a cumulative learning method of teaching, the procedural basis for which is

(a) to activate the experience 'bank' in students and to encourage personal observation

(b) to draw together observation and theory and

(c) to draw on theory to formulate and use physical models of energy, mass and momentum exchanges.

In terms of the published teaching programme these are represented in 1st year core course 'Environmental Systems', 2nd year core course in 'Climatology and Hydrology' and honours electives in Microclimatology and Applied Climatology.

FIRST YEAR COURSE

The first semester (half year) unit of study brings together students from a wide range of academic and environmental backgrounds. Unlike degrees in Geography, no common subject base can be assumed and students bring a wide spectrum of perspectives on climate and weather, as generally defined in experimental terms. This frees course planning from considerations of lowest common denominators or modal experiences, and allows course co-ordinators to plan forward to meet the needs of subsequent degree courses.

Formal teaching of climatology at this level introduces the student to three main aspects of Environmental Science: theory, observation and analysis. Theory considers the movement of air, heat and moisture over the Earth's surface and stresses the importance of surface-atmosphere interaction in determining the distribution of, for example, air temperature and humidity, and wind speed and direction. Observation and analysis are linked to taught theory and focus attention on spatial variation of climate over small areas where there is obvious correlation with surface characteristics.

The instruments used, the whirling psychrometer and hand anemometer, operate on very simple principles and are relatively reliable in the hands of inexperienced observers. Simple experiments are carried out to assess the possibility of observation error and calibration procedures devised. Systematic sampling based on a rectangular grid is used in the first instance. The example, illustrated here is an exercise carried out by students within the first two weeks of starting their degree course at Stirling. The aim is to produce a temperature map for the campus, at the centre of which there is a large body of water.

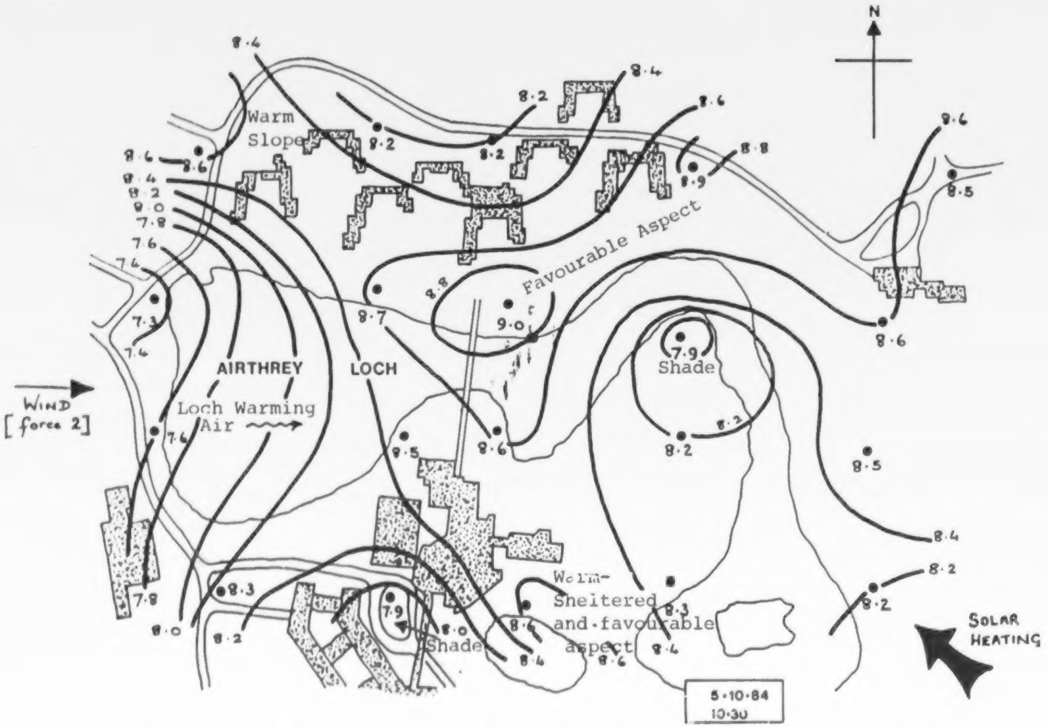
A rectangular grid is superimposed on a map of the campus, with some slight adjustment to keep students on safe dry land. Whirling psychrometer and observer are calibrated at a standard reference site then ten observations are made at the location to which a group is assigned. The students calculate corrected averages then interpolate to produce an isotherm map such as that shown in Figure (1). They are encouraged to annotate the map and suggest factors which may have influenced the pattern. They are also asked whether or not they feel the sampling method to be wholly appropriate.

Some of the comments received in the student reports are inevitably wide of the mark but it is considered important that they begin to develop skills of interpretation. They compare their own ideas with those of the instructor once the exercise has been assessed, usually within one week.

SECOND YEAR COURSE

By the end of the first semester, the students have accumulated what amounts to a number of reasonable hypotheses such as 'buildings affect air temperature', 'air is more humid near to a water body', or 'wind is modified by obstructions such as buildings or trees'. They begin to test these in the second year of study when they have a firmer grasp of the relevant theory. Lecture room teaching is based on physical principles behind heat, energy, and momentum flux in the boundary layer. The course requires the student to understand mathematics up to the level of elementary calculus. Formal teaching is integrated with a weekly three-hour practical class which tends to move away from the construction of spatial patterns of climate into more direct testing of hypotheses. The instruments used are those with which the student became familiar in the first year of study which allows concentration of learning on theoretical aspects, sampling and data analysis.

Typical of the type of exercise carried out is the testing of the effect of the campus loch on the humidity and temperature of the air around it. In the first year exercises most students had suggested that the effect would be an important one in the local climate of the campus. The theory required here relates to the exchange of latent and sensible heat. The experiment itself compares air temperatures and vapour pressure at two points, on the upwind and downwind side of the water body, separated by approximately 400m (Figure 2). Student groups take ten observations of dry bulb and wet


N
Warm Slope
Favourable Aspect
AIRTHREY
LOCH
Loch Warming Air
WIND [force 2]
Shade
Warm-Sheltered and favourable aspect
SOLAR HEATING
5-10-84
10:30
8·4
8·2
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8·8
8·9
8·5
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8·3

FIGURE 1 Typical Distribution of Air Temperature Over Stirling University Campus : First Year Student Fieldwork Exercise

bulb air temperature at th two sites using a whirling psychrometer. They then gather another 40 observations from other groups. After calculating vapour pressure using a standard error. (Figure 2). In the example used here, the loch was very cold which resulted in reduced temperature and vapour pressure as air moved across the water surface.

Apart from relating the findings to theory, the student can also derive a measure of rate of evaporation or condensation if supplied with wind speed data. This type of exercise thus achieves several educational objectives. It not only relates texbook theory to field observation but also introduces manipulation of data and significance testing. Statistical methods are thus introduced through direct application and not through separate methods courses which tend to meet the inevitable consumer resistance.

HONOURS YEARS

At this level, the student of Environmental Science is free to choose his/her own programme from a number of available units. Amongst these are units in Microclimatology and Applied Climatology. These are designed to cater for students who wish either to progress to more detailed considerations of boundary layer climate, or to apply their existing knowledge to practical problems which may relate more to environmental management.

Teaching on the first of these, microclimatology, assumes that the student is familiar with the basic physical theory of process and observation. The equipment used is more complex and the level of mathematics and physics is raised a little. The main thrust of the programme is the evaluation of heat, moisture and momentum fluxes above a number of terrestrial surfaces using physical models. These are based on temperature, vapour pressure and wind velocity profiles obtained, in most cases, using electrical sensors and logging devices.

There is a strong emphasis on data collection and analysis and the students are now responsible for experimental design. The support provided includes several purpose built computer packages on the University's mainframe VAX computer. These are interactive and allow the student not only to analyse data collected but also to be led towards a better understanding of microclimatic processes through manipulation of variables.

A typical two hour field exercise would involve comparison of, for example, the surface energy balance of long and short grass on similar soils and under the same radiant energy input conditions. Air temperature (dry and wet bulb) and wind velocity are measured at fixed heights above the surfaces and models used to derive sensible heat, latent heat and soil heat fluxes. The frequency distribution of the derived flux values provides an indication not only of the contrast between the surfaces and the effect of roughness length, but also of the short term variability and the partitioning of heat

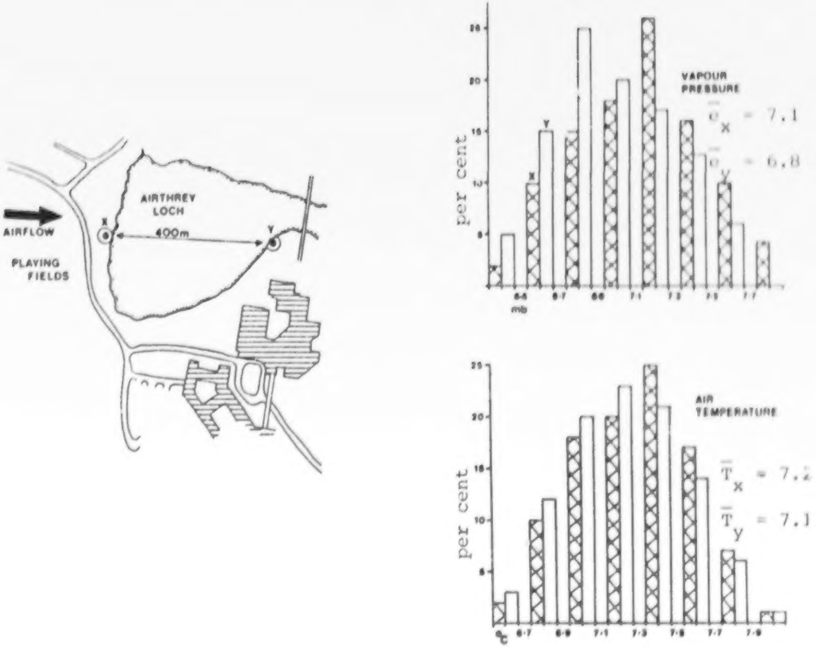


FIGURE 2 Effect of a Water Body on Air Temperature and Water Vapour Pressure : Second Year Student Exercise

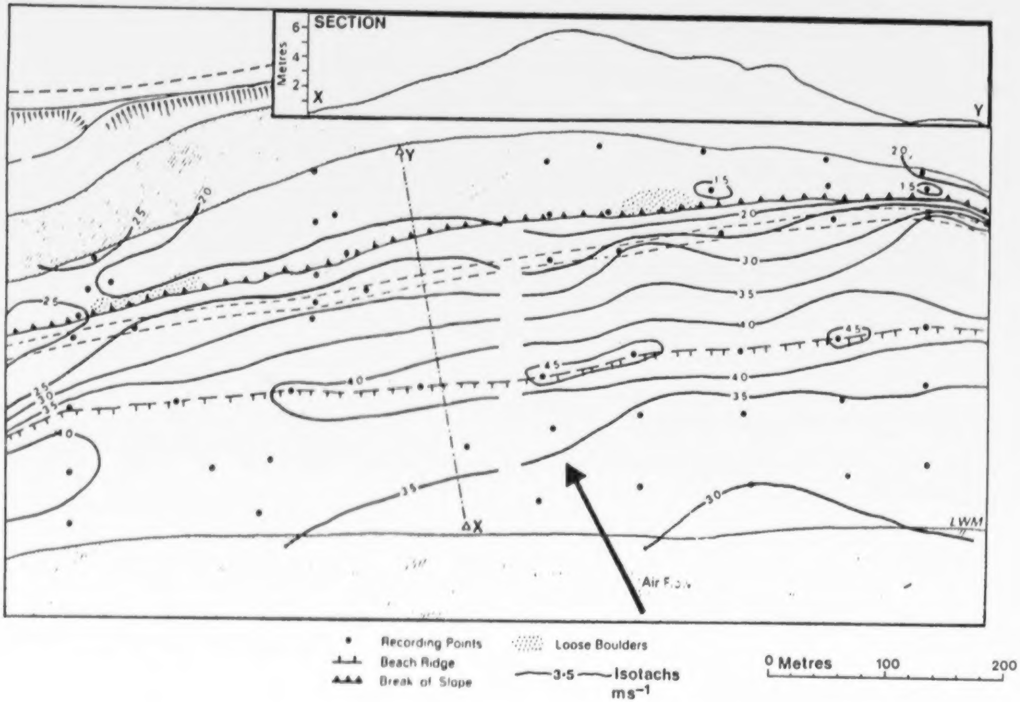
flux over moist grass surfaces.

Spatial aspects of study are also incorporated into the course and include the distribution of light intensity under forest canopies and airflow patterns around obstacles. Again, the design of experiments is left to the students who are set the problem and provided with the tools. The experimental design is discussed with staff before observations are allowed to begin. In the example (Figure 3) students were asked to investigate the pattern of airflow over a storm beach, using hand held anemometers. The two groups opted for slightly different sampling techniques but nevertheless produced broadly similar isotach patterns. This was then linked to theoretical considerations of airflow over obstacles.

The alternative, applied climatology, is offered to students who do not wish to add to their 'theory bank' but wish to apply what they know to particular environmental problems. According to Oliver (1967) ..."It is in the field of applied climatology that Climatology and the Environmental Sciences are most closely related". While some aspects of the subject, such as shelter effects, provide opportunities for student involvement in fieldwork exercises, teaching has tended to be based on lectures and seminars. This can remove the problem solving element which is such a valuable educational tool. At Stirling, this element has been retained by adopting a 'hazards' approach which poses the multidimensional problems of assessment adjustment and control. As solutions to hazard problems are invariably compromises between a large number of interacting and often conflicting interests, role-playing is used on the course. Students are provided with full background details of the particular hazard and are assigned roles. They are given one week to research their roles before sitting around a table to discuss the problem. The course co-ordinator chairs the meeting which is run in a business-like manner. After two hours the chairman sums up and the students write a synopsis of the discussions.

The example in Figure (4) relates to the occurrence of fog on a motorway. The area has a long history of accidents. The representatives of various organisations or groups bring conflicting interests to the meeting, which must be reconciled before conclusions can be reached. In the early part of the meeting there is a tendency to apportion blame rather than constructively seek solutions. The shortage of meteorological data, poor long term planning, poor warning signs, inadequate emergency access, and irresponsible driving are among the favourites. Only when the air has been cleared does the meeting turn to dealing with the problem.

This type of exercise not only involves the student more actively in the learning process but it is also useful experience for dealing with real problems encountered after graduation.


SECTION
Metres
6
4
2
X
Y
20
15
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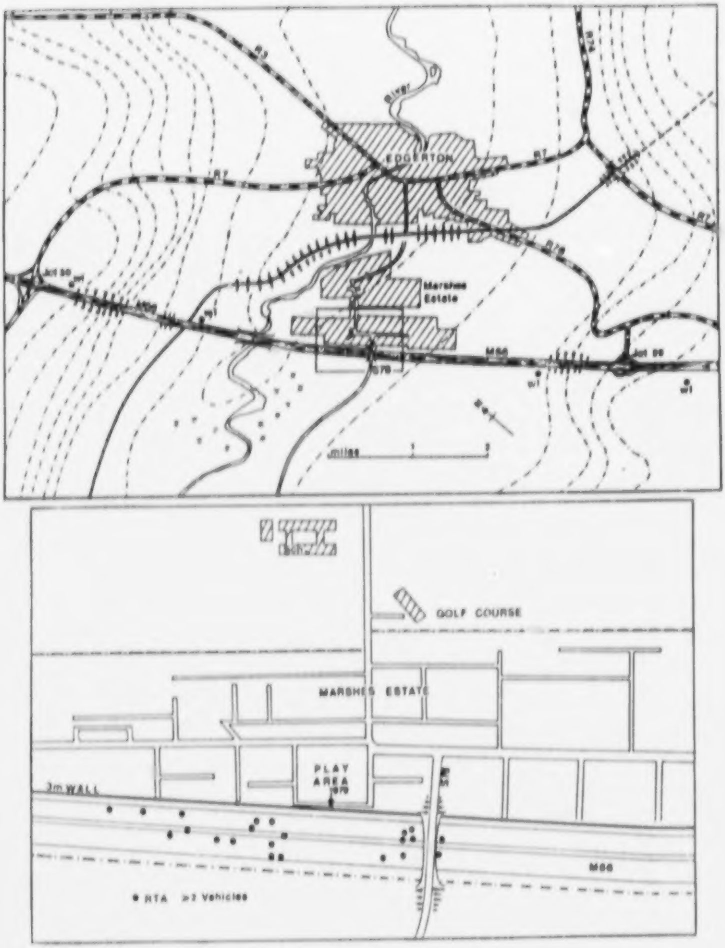
LWM
Air Flow
Recording Points
Beach Ridge
Break of Slope
Loose Boulders
3·5 Isotachs ms⁻¹
0 Metres
100
200

FIGURE 3 Airflow Patterns Over a Storm Beach : Microclimatology Elective


EDGERTON
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● RTA ≥2 Vehicles

FIGURE 4 Motorway Fog Hazard Role-Playing Exercise : Applied Climatology Elective

CONCLUSIONS

The use of boundary layer climate as a focus for climatological studies in Environmental Science at Stirling University has proved to be very successful. The material taught has integrated very well into the degree programmes. Student reaction has been favourable despite the level of physics and mathematics. The cumulative learning approach would appear to be a successful and relatively painless way of building on the students' own experience of atmospheric behaviour.

In terms of resources, the equipment required for the first and second year courses is relatively inexpensive but higher level work does require a greater capital investment. The greatest investment is, however, in staff time and effort. Commitment to this style of teaching has to be total and it is important that attention is paid to the needs of the individual. Exercises must be assessed on a regular basis and quickly in order for the student to progress. Role playing is particularly demanding as it requires thorough preparation and ability to chair a meeting without discouraging frank exchange of views and without imposing direction.

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ENVIRONMENT MANAGEMENT IN RESERVOIR OPERATION

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INTRODUCTION

Many types of decision have to be made in the environment. Much attention, with regard to both political and scientific aspects, has been focussed on decisions on development - whether a particular project should proceed or not. This paper focuses on the comparatively neglected question of operation and management of such projects, and argues that this area should be the concern of the emergent environmental scientist and decision maker. To do this, the case of reservoir operation will be taken. Water resources in general, and reservoir development in particular, have been seen politically and scientifically as a major arena for environmental decisions. It is no accident that the development of decision-making techniques such as Cost-Benefit Analysis (CBA) and Environmental Impact Analysis (EIA) has been prominent in this area. The author's recent research (Hill, 1984) has concentrated on the relationship between reservoir, operation, drawdown and recreation. The results of this research have been incorporated in the teaching of countryside management in the final year of the Sunderland Polytechnic B.Sc. Environmental Studies course. This paper is concerned with the application of techniques in project management, and seeks both to illustrate their role and to demonstrate the need for environmental involvement in ongoing project operation. Firstly, the background to reservoir operation, its significance and problems raised are considered. More specifically, the effects of operation and drawdown on recreation are examined. Secondly, the ways of deriving recreation sympathetic operation and the use of techniques in this are explored. Finally, the paper returns to the implications arising from this example for environmental studies in higher education.

RESERVOIR OPERATION

Reservoir operation involves the scheduling of water releases and hence determines storage volume, water depth and surface area at a particular time - subject of course to the longer term influence of inflows; the usual aim is to secure the efficient use of water. Operation may be of single reservoir, or involve multiple sources (several reservoirs, or other sources, operated together). In either case, operation may be for one purpose, usually water supply, hydropower generation or flood control, or multipurpose. Multipurpose operation usually involves a compromise in the sometimes conflicting requirements of the different uses. Otherwise, the basis of operation will vary according to the purpose. The way in which releases are controlled in response to these problems is called the release or operating rule (McMahon & Mein, 1978), whilst Maas et al (1962) define an 'operating procedure' as a set of rules for storing and releasing water from reservoirs. An operating policy, or procedure, is a whole series of rules that are required to operate a water resource system both in normal times and difficult times (e.g. drought for water supply). The policy may have many parts, including basic design rules, emergency rules and rules designed to reduce costs. A further dimension is the time scale of operation with regard to long term guidelines (often months), short term strategies (e.g. to return to guidelines), and immediate responses to events (or 'real time operation').

Because it is usual to represent these rules, especially for the longer term, graphically, they are termed 'control rule curves'.

The actual deprivation of a rule or policy may be by:

a) producing a fixed 'rule', perhaps directly calculated (for instance, in the case of water supply, from the worse historical droughts)

b) modelling operation, using mathematical optimisation techniques, simulation, or a combination or both (based either directly on historic records, deterministically or on generated inflows stochastically).

The latter approach becomes particularly important for multiple sources and/or multiple purposes. Toebes and Rukvichai (1978) take a unifying view of the two approaches, regarding optimisation models as 'screening devices'.

The majority of U.K. reservoirs and systems are for water supply, and for almost all, operation is single purpose, regardless of other uses to which they may be put. Institutional constraints reinforce this, and water authority operations divisions are staffed almost exclusively by engineers. Procedures and rules are designed to provide releases for demand plus river compensation (for direct supply reservoirs) or quantities required for river regulation, adjusted for problems of scarcity. There is seldom any recognition of conflicts with other purposes. A typical hypothetical control curve for water supply is illustrated in Figure 1. Releases are made in full unless levels fall below the control line; there is no control over substantial drawdown during the summer.

Increasingly, in the U.K. and elsewhere, links have been developed enabling flexibility in drawing upon several reservoirs, or other sources, to serve particular demand areas. For multiple sources, the combined safe yield of a conjunctive scheme may be greater than the sum of the individual safe yields (Twort et al, 1973). A major factor with regard to linking sources is the flexibility in operation afforded. With regard to the Lancashire Conjunctive Scheme, Walsh (1971) described how a reservoir may be 'overdrawn' because of fall

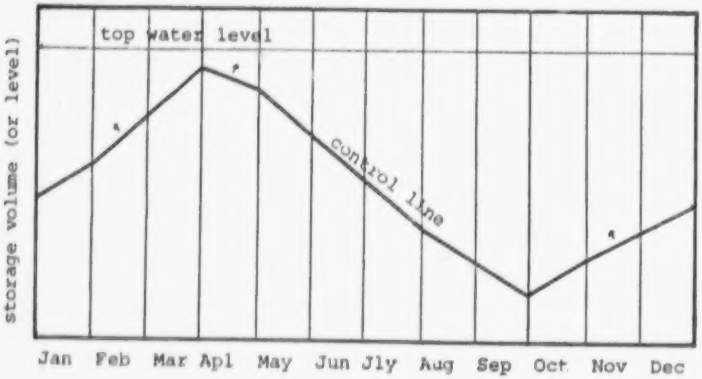

Fig 1. Typical water supply reservoir control rule curve

back on non-reservoir sources. Increased drawdown may result, so that in this case multiple-source operation may work against the interests of recreation. Where the multiple-sources are all, or mainly reservoirs, the 'synergistic' gains (so termed by Hirsch et al, 1977) through multiple-operation may be less, but flexibility in operation remains. Indeed, in economic terms there may be greater effective flexibility because marginal costs of the different sources are more likely to be similar. Thus, even without taking into account recreational benefits there may be some incentive to vary operation and manipulate drawdown variations. In some cases inter-basin pumping costs may arise (e.g. Kielder Reservoir to Teesside in N. E. England) and will preclude flexibility unless other benefits can be taken into account, i.e. with economic or 'environmental' operation. Figure 2 illustrates a multi-source system where costs may vary.

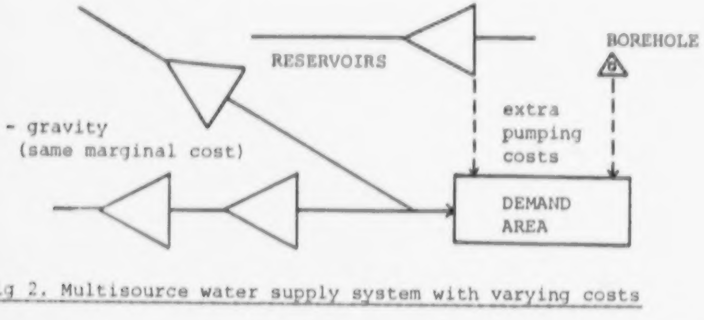

Fig 2. Multisource water supply system with varying costs

Many reservoirs are built and operated for purposes other than water supply; some are operated for a purpose other than their original. Increasingly, reservoirs are being called upon to perform more than one purpose. The introduction of recreation, or the initial inclusion of its interests in operation may occur in the case of any other single purpose or combination of purposes. The major conflict with recreation is with water supply (the main U.K. type), where, for both direct supply and river regulation, reservoirs tend to be drawn down during the summer (peak recreation season). Potential conflict with flood control should be less of a problem, though some drawdown may occur late in the recreation season in anticipation of floods. Conflict with hydropower generation (significant in some parts of the U.K.) is less stereo-typed and varies according to head/discharge relationship, role in overall power supply and differential tariffs.

It is argued (Hill, 1984) that there should be scope in the U.K. operation to reduce conflict by changing the scale and/or timing of darwdown in one or more reservoirs in any system through:

a) the immediate flexibility offered by multi-source systems where there is little difference in marginal costs,

b) the development of true multipurpose operation where recreation costs and benefits may be taken into account in the economic/environmental derivation of operating rules.

The latter would require the involvement of a range of disciplines in operation, and a broad environmental overview. Before considering the extent to which any opportunities should be realised, the scale and significance of drawdown effects on recreation should be assessed.

EFFECTS OF DRAWDOWN ON RESERVOIR RECREATION

Drawdown reduces depth, reduces surface area and causes changes in bank profile, shoreline surfaces, bank appearance and reservoir ecology. Drawdown depth varies with type and size of reservoir. A questionnaire survey (Hill, 1984) of U.K. water authorities revealed a typical (1 in 5 year) range of maxima of 1 to 16 metres, whilst drawdown on some large U.S. reservoirs may be as much as 50 metres (Tennessee Valley Authority, 1977). Such drawdown might certainly be expected to produce changes. The effects will depend on the reservoir characteristics and the nature of the recreational activities affected. Jaakson (1970) in particular, recognised the importance of reservoir characteristics such as shoreline morphology. Drawdown directly affects water space and shoreline available, for these are functions of depth, bank slope and reservoir shape. An analysis for a range of reservoir size and bank slope (Hill, 1984) showed that for moderate drawdown (the average from the water authority survey), area is reduced by 20 to 60% and shoreline length by 10 to 40%. Even slight drawdown (say 1 metre on a 20 hectare reservoir) can result in a 10 to 25% reduction in area and loss of 5 to 25% of shoreline. Thus even though drawdown figures quoted for a particular reservoir may not 'sound very much', the loss of capacity may in fact be significant. This may be especially so when usable rather than total area is considered, and reduced depth is taken account of.

For boat-based activities, reduction in area and usable area is of direct significance. Usability may suffer, as parts of the whole of laid out courses become unusable and shallows restrict access. Launching facilities may become unusable; some types may cover a range of depth, though the greater the flexibility the greater the cost. In the questionnaire survey, the majority of U.K. water authorities regarded drawdown effect on boating as adverse, especially for sailing. Access for canoeing may be less of a problem but carries over distance or mudflats may deter users. For fishing, boat or bankside access is important. The relationship between drawdown, fish population and angling success have not, despite research, been clearly established. There is strong evidence that it may be adverse, but duration and scheduling of drawdown are important, as well as scale. Mixed opinions on effects on fishing were expressed by the U.K. water authorities. For swimming, where permitted, beaches may become unusable (though they may be extended artificially). Casual recreation presents difficulties; it is a major and growing area of reservoir recreation, yet there is less information on participation rates. Shoreline access and aesthetic appearance are the major variables. A problem is the inherent objectivity in aesthetic changes, and the variation in significance attached to these by individuals in different activities. The U.K. water authorities generally regarded drawdown as having little effect on casual activities; research on this is continuing.

Drawdown is widely recognised in the literature as a problem for reservoir recreation; there is broad agreement that excessive drawdown and wide fluctuations reduce recreation benefits. The problem then is to establish what is excessive and how to quantify loss of benefits. Some studies have sought to establish the relationship, but attempts to quantify benefit loss have been based very much on assumptions which tend to be empirical or conjectural. Recent studies regarding drawdown impact as significant include the Tennessee Valley Authority (1977) (Figure 3 shows its assumed relationship), Toebes and Rukvichai (1978), McMahon et al (1980), Labadie et al (1980) and Ford et al (1981). There is an acknowledged need for rigorous research to justify the basic assumptions. The survey of U.K. water authorities indicated a recognition of the significance of drawdown, but not in any quantifiable form. The research is being continued to include the views of clubs and individual users; potential users should be included, though this presents greater difficulties.

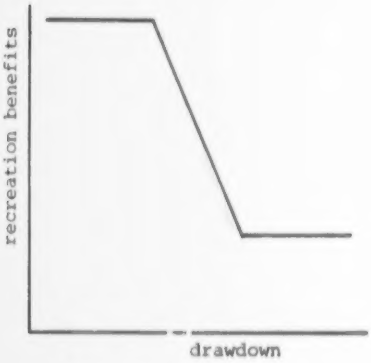

Fig 3. Recreation-benefit/drawdown relationship
(after Tennessee Valley Authority, 1977)

DRAWDOWN MANAGEMENT AND THE APPLICATION OF TECHNIQUES

Whilst several conclusions are tentative, and further research is required, it is considered that there is sufficient evidence to support the hypothesis that drawdown of reservoirs reduces recreation benefits. It is therefore recommended that, in addition to ongoing research, action should be taken to reduce the ill effects of drawdown. To this end, what has been termed a programme of 'drawdown management' should be instigated. This should involve the maintenance of access to water over a certain depth range, the encouragement, where feasible, of margin revegetation, and more specifically relating to the study, the manipulation of drawdown through reservoir operation (within any limits of flexibility). Steps in such a programme for U.K. water supply reservoirs from short term to long, could include the following:-

i) explore scope for flexibility in operation whereby summer drawdown could be restricted at recreationally important reservoirs, within the limits of minimal increases in margina costs of water supply,

ii) modify reservoir operation within such limits to maintain summer amenity levels where appropriate,

iii) within the restricted drawdown range for such reservoirs (and as far as possible for other reservoirs)

    a) maintain access to water
    b) encourage margin revegetation where possible,

iv) in the longer term, attempt to include recreation benefits,

v) explore scope for flexibility in operation over a wider range of marginal costs, offsetting increased water supply costs against recreation benefit increase,

vi) derive operating rules on this basis to maintain summer amenity levels for reservoirs offering good recreational opportunities,

vii) move to true multi-purpose operation, using optimisation and simulation techniques to derive economically-based operating rules for all reservoirs.

The use of decision making techniques is important, especially at the later steps in such an approach. Steps (iv) to (vi) require some estimation of the mostly intangible recreation benefits, including reduction of benefit due to drawdown. For effective multiple use, the benefits derived from the various uses should ideally be aggregated in some common form. Thus it is desirable to estimate recreation benefits in a rational and comparative way if recreation is to be taken into account in reservoir operation and project selection (where simulation models are used to aid selection, operation may be a significant component of such models). Research suggests that reservoir recreation benefits may be substantial, contributing up to 35% or more of total project benefits (Hufschmift & Fiering, 1967); in the U.K., Smith (1970, 1971) estimated the annual benefits from sailing and fishing alone at one reservoir as £53,000. The valuation should be based on sound economic principles of Willingness-to-Pay criteria, the basis of most cost-benefit studies of water resource projects. Of the methods developed, the travel-cost (Clawson, 1959) method seems appropriate, applying the selection procedure of Sinden and Worrell (1979), for reservoir recreation. The method including more recent refinements has been widely used, though in research more than practice, both in the U.S.A. and U.K. A critical test of a method is its ability to differentiate between different operating outcomes, with regard to variables such as capacity and attractiveness. Demand curve imputation methods, including travel-cost, offer scope for this, though capacity changes have seldom been explicitly allowed for, and further work on the direct inclusion of site attractiveness is required. Inclusion may be by considering average characteristics, or potentially more accurately by subtracting losses from an optimum level. The use of multi-objective planning techniques may avoid monetary quantification of intangible recreation benefits, though other problems arise; Major (1977) considers the practice of multi-objective planning in water resources. Croley (1974) describes how objective trade-offs may be included in reservoir operation.

Step (vii) directly involves optimisation and simulation techniques. This was first done, using recreation benefit and loss functions, in the Harvard Water Program (Hufschmidt & Fiering, 1967). Such applications have continued, mostly in N. America; the most comprehensive application has been by the Tennessee Valley Authority (1977).

Such techniques have not been applied in the U.K., where there has been a reliance on control rules derived for water supply alone (Hill, 1985). The survey revealed only one case of inclusion of recreation in operation, where the Northumbrian Water Authority (1974) attempts to maintain a 'summer amenity' level for recreation at two Teesdale reservoirs. Even with a multipurpose approach to operation, there may still be affects on factors not accounted for, which developing environmental impact assessment methods seek to address. Clearly the conventional engineering approach to reservoir operation should take a broader environmental dimension.

IMPLICATIONS FOR ENVIRONMENTAL STUDIES AND ITS TEACHING

Several implications arise from this topic both with regard to the role of the environmental scientist and with regard to the teaching of environmental studies. The environmental scientist should recognise that, when a project such as a dam is approved and completed, his role is not finished, and that concern with an involvement in operation/management is appropriate. All too often the job of the environmentalist is seen to be done when the much desired or much opposed scheme comes about. The range of disciplines involved in environmental management such as multipurpose reservoir operation is wide, and the environmental scientist is perhaps in the best position to advise if not make decisions.

The environmental scientist should be equipped to do so, and should have a critical awareness of the strengths and limitations of environmental decision making techniques and the ability to select and apply them. One issue that arises is whether techniques used in the determination and recreation sympathetic reservoir operation should be taught in a 'recreation' unit, or in a unit dealing with techniques alone. At Sunderland Polytechnic, separate 'techniques' are being developed to include theory and critique, whilst detailed applications are dealt with in other units. A danger is that techniques taught in isolation may appear artificial and dull if not related to real problems and practical application such as reservoir operation. Even if a theoretically optimal choice is available, the importance of political, legal and administrative constraints should be recognised; for instance in the U.K., the mainly intangible recreation benefits from reservoir use do not accrue to the water authorities - making true multipurpose operation difficult! Thus the emergent environmental scientist should be taught to be ready to deal with these constraints when building on the scientific and operational aspects of environmental management.

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A CASE STUDY ON PERCEIVED HEALTH RISKS OF AIR POLLUTION IN ATHENS, GREECE.

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INTRODUCTION

The rapid urban growth of Athens during its 150 years as capital has been phenomenal. In 1861 the city held 41,300 people, by the 1981 census this number had risen to 3,027,331 recorded as living in Athens. During the same period the population of Greece has shown a ninefold increase. When the percentage of the total population that lives in Athens is examined over this period, in spite of the territorial gains, there has been a steady increase until today when 31.08% of all Greeks are congregated into this one large urban area. The consequence of this unplanned urban-rural drift is a high density of housing with inadequate road access. The resulting pressure on open spaces has left Athens with 2.7m^2 per capita, compared with Paris 8.4m^2 per capita, London 9m^2 per capita, and Vienna 15m^2 per capita. Blocks of flats combine with narrow streets to form canyons that trap the exhaust fumes form slow moving vehicles. The average speed of traffic in Athens at peak hours is only 7km/hr, less than half that of London. Not only is the speed in Athens barely faster than walking, at these speeds car engines run most inefficiently.

Athens is surrounded by mountain ranges to the north, east, and west and by sea to the south. These natural features have provided natural boundaries limiting the expansion of the city, which has reached the foothills of all the ranges. The effect that the mountains and the sea has on the circulation of air for the city and its industry is very significant. The mountains are sufficiently large to prevent the air over the city from being carried by the sea breezes. Also frequent temperature inversions combine to produce a stagnation or slow circulation of air between coastline and mountains similar to Los Angeles. (Scorer, 1973).

There were 94 episodes of high smoke concentrations in Athens during the period 1974-1982 (Lalas, 1983), and between 1980-81 the limits for emergency measures were exceeded 8 times. Despite this, environmental groups appeared later than in many comparable countries, have limited membership, financial support, and influence on public policy (OECD, 1983).

There is a long history of focusing attention on dramatic smog episodes. London in 1873, 1880 and 1891, Glasgow in 1909, Manchester and Salford in 1930-31, the Meuse valley in 1930, Donora in 1948, London again in 1948, 1952, 1956 and 1962 and New York in 1953, are all notable examples (National Society for Clean Air, 1985). The Public's perception of the seriousness of any hazard is influenced by the number of deaths that result (Lee, 1983), and smog episodes are no exception. It was in response to the estimated 4,000 deaths attributed to the London smog of 1952 that the Clean Air Act of 1956 was introduced.

Pollutants examined in these earlier incidents were SO_2 and smoke, which produce a chemically reducing smog. Filters and switching to fuel with a lower sulphur content has tended to lessen this hazard. However, a new problem has arisen, photochemical smog that is much more complex chemically. It is a smog of this type that forms the cloud or 'nephos' over Athens. Such conditions have not as yet been shown to produce the mortality of the previous noted incidents. They are suspected, though, of causing widespread subacute symptoms like headaches, fatigue, insomnia, burning eyes, difficulty in concentration, impaired judgement, and depression (Laverne, 1970).

HEALTH SURVEY

In 1982 a Health and Safety Executive (HSE) survey made a comparison of industrial, work-related, and other risks, among which was air pollution. The first study to be reported in this paper makes use of some of the questions from the HSE survey plus some further questions that in addition to a cross-cultural comparison permit a more detailed analysis of people's beliefs about the health hazards of air pollution. (Prescott-Clarke, 1982).

There were three groups, all resident in Athens; a group of college students (N=150), a group of their parents (N=28), and a group of civil servants (N=34). The questionnaire was translated into Greek using the back-translation technique.

When asked about the possible health hazards of the air in their neighbourhood, 37% of the students, 36% of the parents, and 56% of the Civil Servants thought that the air in the area in which they lived contained something that was bad for their health. A comparison of city centre dwellers with suburban dwellers revealed a marked difference, with 70% of those living in the centre, against 30% of those living in the suburbs believing that the air could be bad for their health. A similar pattern was found when subjects were asked to rate the area in which they worked (Table 1). In the HSE survey 32% thought there was something in the air bad for health, which rose to 40% when only those located in a city or large town were examined.

In contrast to many other risks over which people feel they have some control, the health risks from air pollution leave people with a feeling of helplessness. Over 75% of all three Athenian groups felt that they could do 'not all that much' or 'nothing at all' to prevent air pollution from seriously damaging their health. This finding is in complete agreement with the HSE survey which found only 5% saying they can do 'a lot' to prevent this risk.

This threat to health combined with a feeling that the situation was out of their control quite naturally produced a considerable amount of worry. Worry increased with age, parents (79%) and civil servants (97%) worrying more than students (78%) though all registered a high level of concern.

When asked if the harm was serious enough that it could lead to an early death 22% of students, 21% of parents, and 45% of civil servants answered that they thought it could. This figure is more than double the 8% found in the HSE survey.

Yet despite these fears of serious health problems and even early death, when questioned more closely about the possible ways in which their health was likely to be affected by air pollution all replied headaches and eye irritations as the most likely (Table 1). These are the classical subacute symptoms of a photochemical smog.

Respondents in all groups when asked about the likelihood that air pollution could seriously damage their health gave answers about the mid point of the scale. The perceived likelihood increased with age. After completing this section of the questionnaire respondents were further interviewed with regard to their beliefs about the health risks of their children and parents.

Analysis showed that the old and the very young were seen as being particularly at risk. Parents rated their parents at 8.2 on a scale of 10, and civil servants rated their children at 9.0 on a scale of 10. When questioned more specifically about the ways in which the health of their parents or children might be affected, again headaches and eye irritations were cited as the most likely.

It is a most difficult epidemiological problem to attribute any one death to air pollution exposure. There is a wide variation of human sensitivity to air pollutants, with children and the elderly being the most susceptible. The best analysis that can be achieved is a correlation between increased levels of pollution and increased numbers of deaths, usually of respiratory diseases. In the past smog episodes have typically been reported in thsi manner. In London in 1952 an estimated 4,000 excess deaths were attributed to the smog, and an additional 1,000 deaths were attributed to the smog of 1956. Sometimes an episode is not noticed until years later, this was the case with New York, an excess of 200 deaths due to a stagnation of SO_2 and smoke in 1953 were not recognised until 9 years later, when a re-analysis brought this to light.

Respondants in all three groups were asked about the number of deaths each year caused in some way by air pollution, a similar question had been included in the HSE survey. The modal answer given by the Greek sample was 500 deaths a year (Table 2) of a yearly total of 86,000 deaths. In the HSE survey the modal reply was 1,000 deaths a year, this was given in the knowledge that the total number of yearly deaths in Britain was 6000,000. In their conclusions fewer deaths

TABLE 1 Beliefs About Health Damage from Air Pollution

Q. If your health was affected by air pollution, which ways do you think are the most likely?

Scale : Most Unlikely 1, Most Likely 6

	Students Mean	Parents Mean	Civil Servants Mean
Headaches	5.07	4.94	5.13
Eye Irritation	4.72	4.89	5.33
Irritability	3.85	3.47	4.16
Cough/Chest Infections	3.85	3.97	4.73
Skin Allergies	3.69	3.61	3.83
Depression	3.65	3.08	3.80
Lack of Concentration	3.39	2.76	4.05
Lung Cancer	3.30	3.82	4.22
Asthma	3.01	4.29	4.04
Insomnia	2.93	2.72	3.48
Bronchitis	2.73	3.78	3.56
Digestive Problems	2.25	2.53	3.02
Ear Infections	2.05	2.11	2.44
Pneumonia	1.75	2.29	3.22
Diarrhoea	1.70	1.86	2.43

were attributed to air pollution than any other of the surveyed risks with the exception of diseases caused by nuclear plants. Given the higher proportion of the Greek sample it is concluded that the risk from air pollution is perceived as being more serious for the Athenian sample.

TABLE 2 Perceived Number of Deaths Each Year from Air Pollution

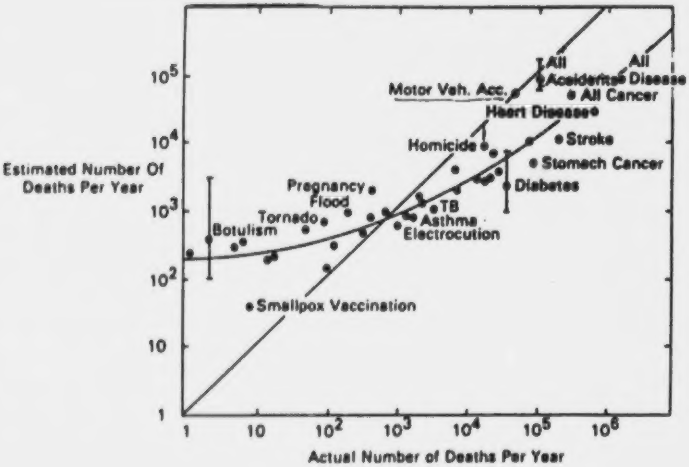
Q. Of the 86,000 people who die each year in Greece, how many do you think die from serious diseases caused in some way by air pollution?

Number of Deaths Per Year	All Subjects (145)
5 People	1
10 People	15
50 People	10
100 People	20
500 People	30
1000 People	27
5000 People	29
10000 People	13

Slovic, Fischhoff and Lichtenstein (1979) reported a systematic bias in people's judgement of the frequency of various causes of death when compared to the statistical estimates. They found that rare causes of death tended to be overestimated and that common causes of death were underestimated. In their study subjects were given the actual number of deaths from motor accidents and their task was to make estimates for the other causes. Motor accidents were around the central position. People consistently underestimated the difference between the likelihoods of the most and least frequent causes of death. (Table 3)

In an attempt to come to a better understanding of the psychological processes of these judgements a further investigation was undertaken. 67 Greek college students volunteered to participate in this experiment in which they were presented with cards naming 11 different causes of death - Cancer, Heart Diseases, Motor Accidents, Accidental Falls, Murder, Diabetes, Suicide, Drowning, Pneumonia, Tuberculosis, and Appendicitis. Firstly, they were asked to sort the cards into the order which showed the most frequent cause through to the least frequent cause. Next, they were asked to estimate the number of deaths for each cause. At this stage the subjects were divided into two groups. Group 1 was given the information that 35,000 people died every year in Greece from heart diseases, the highest single cause of death. Group 2 was told that 82 people were murdered every year in Greece. A very clear pattern of results was obtained, those subjects who were given the high number overestimated the other causes of death, whilst the groups given the low figure underestimated

TABLE 3 Relationship Between Judged Frequency and Actual Frequency for 41 Causes of Death



Source : Sloviv, Fischhoff and Lichtenstein (1979) the other causes of death. From this it is concluded that the general bias reported by Slovic, Fishhoff, and Lichtenstein is an artifact of their choosing to supply their subjects with the number of deaths from motor vehicle accidents. What seems to be happening is that subjects have a limited idea of the range of numbers involved and are using the given figures as a base from which to estimate a rather limited range. No doubt this effect would have influenced the numbers reported in the HSE survey and the survey reported in this paper, leading to an overestimate in both cases.

CONCLUSION

In conclusion, the worry and concern that people have about air pollution are well documented. What needs to be investigated further is how the individual resolves the conflict between a perceived threat to health and the inability at the individual level to control the situation.

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A CASE STUDY ON MARITIME LITTER AS A MAJOR ENVIRONMENTAL POLLUTANT

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INTRODUCTION

'Adroit Civil Service manoeuvering has circumvented the EEC regulations that should have forced Britain to clean up its beaches. They remain among the most unsavoury in the Western World' (Pearce, 1981).

Litter is one of the most evident aspects of environmental pollution. Litter is the product of human activity and is nowhere more abundant than in highly industrialised societies, particularly those which have a free market economy with intense competition and with a consequent image of the 'throwaway society'. Litter is a phenomenon of contemporary society and has become a major pollutant, partly due to the sheer volume of materials discarded, and partly due to the development of durable plastics and their widespread use in containers and packaging.

Litter is hard to define. For practical purposes, in the Cramond and other Forth studies, litter has been defined as, 'material (metal, paper, glass or plastic) manufactured or utilised by man and discarded after use'. Much litter, which is of naturally-occurring organic material, disappears by biodegradeable processes in a reasonably short period of time, whilst litter of metallic origin takes much longer to corrode and disintegrate. Durable plastics may never disappear, but break up physically into small fragments (e.g. 'plastic sand').

Litter occurs wherever people go - thus both land and water are recipients of litter, either by direct dumping, or by 'fall out' from the air as a function of wind dispersal. Much litter that is produced can be a health hazard, both for humans and animals alike. Considerable evidence of dumping of toxic substances on southern U.K. beaches - residues in containers - has been found (Dixon & Dixon, 1981). Many recent reports have come to light concerning the widespread death of swans, in particular the Mute Swan, due to lead poisoning from ingested/discarded/lost lead weights used by fishermen in inland waters (Habitat, 1982, 1983a, 1983b, 1984). Fatalities of marine birds and mammals due to enmeshment in broken/discarded fishing nets, and suffocation and intestinal blockage due to swallowed balls of polythene sheeting, are commonplace around the world, and the cause of considerable concern to conservationists (Horsman, 1985).

The social impact of litter is no more abundantly evident than in areas where human beings congregate in large numbers. Thus urban, suburban, rural and maritime areas all receive their share of litter. The unpleasant psychological impact of litter - strewn beaches or public parks, for example - is not conducive to the wellbeing of tourists or local holidaymakers. Added to this is the potential health and accident hazards posed by broken glass and the brittle edges of fractured plastic containers.

THE CRAMOND CASE STUDY

Recent studies on maritime litter at Napier, have centred along the southern shoreline of the Firth of Forth, Scotland, much of which forms Edinburgh's coastline (Maps 1a and 1b). Investigations into the litter on various stretches of beach involved, were begun as a result of a visit to the Cramond foreshore in the summer of 1983, following strong, gale-force winds. The beach was strewn with debris, dominated by clothing, containers, plastic bags and sheeting fragments.

Cramond Village (P.S. Grid Ref. NT 192771) lies some 7.24kms (4½ miles) to the north west of the city centre of Edinburgh, at the confluence of the River Almond and the Firth of Forth, the former forming the western boundary of the village. An offshore island, Cramond Island, is joined to the eastern margin of the confluence by a breakwater, which gives foot access to the island at low tide. The beach study area lies to the east of the breakwater's proximal end, and is divided into two parts: an upper sandy-pebbly portion, with scattered small maritime plant colonisers of open bare sand; and a lower tide-washed foreshore of sand with pebbles increasing in occurrence to the eastward. The upper beach is rarely washed and only at high water Spring tides, when the weather is rough. Otherwise, cleansing depends on rainfall.

Cramond is a popular tourist and visitor centre, catering for a wide variety of activities and pursuits, among which may be mentioned: boating, wind surfing, horse-riding, angling, bait collecting, archaeology, painting, guided walks and picnicing. Some seven thousand people live in Cramond and the adjacent Barton ward, many of whom frequent the village and foreshore throughout the year. The Cramond Yacht Club attracts over one hundred registered pleasure craft (keel boats and sailing dinghies), of which sixty or more are on the water at regatta times and some ten to twenty craft are the norm.

Litter has been a major problem at Cramond for a considerable time, manifesting itself in particular along the foreshore and upper beach as well as the perimeter of the adjacent car park. There is no doubt that in part, this litter has its origin in the local area from the resident and visiting population. However, a considerable fraction is washed ashore on the estuarine tides of the Firth. In addition to the volume of pleasure craft localised at Cramond, there is a

Map 1a - Scotland (U.K.)

Map 1b - Firth of Forth

considerable volume of maritime traffic both military and mercantile. For example, during the whole of 1984, there were over 23,000 shipping movements in the Firth, with the addition of some 3,000 transit movements of both categories of maritime shipping. Thus Cramond lies in the midst of a busy sea lane and is also the focal point for much recreational activity.

For six months (April-October) during 1984, a weekly study was made of the foreshore litter at Cramond, to ascertain the composition both qualitatively and quantitatively and to determine, where possible, the origin of the material. Nineteen categories of litter were recognised in the Cramond study - of these, three were Container and sixteen were Non-container. The range of observations of each of the categories is shown in Figure 1. The bulk of observations related clearly to clothing, plastic sheeting and bags in the Non-container categories. All three types of Containers were plentiful, but were dominated by metal ones. Pie charts showing Total Litter (Figure 2) and Container Litter (Figure 3), illustrate well the relative abundance of the litter found. The pattern of the Container litter categories (Figure 4) shows an interesting effect mid-way due to a "clean-up" by the authorities, following press publicity of the study.

Fig. I

LITTER ON CRAMOND FORESHORE

APRIL - OCTOBER 1984

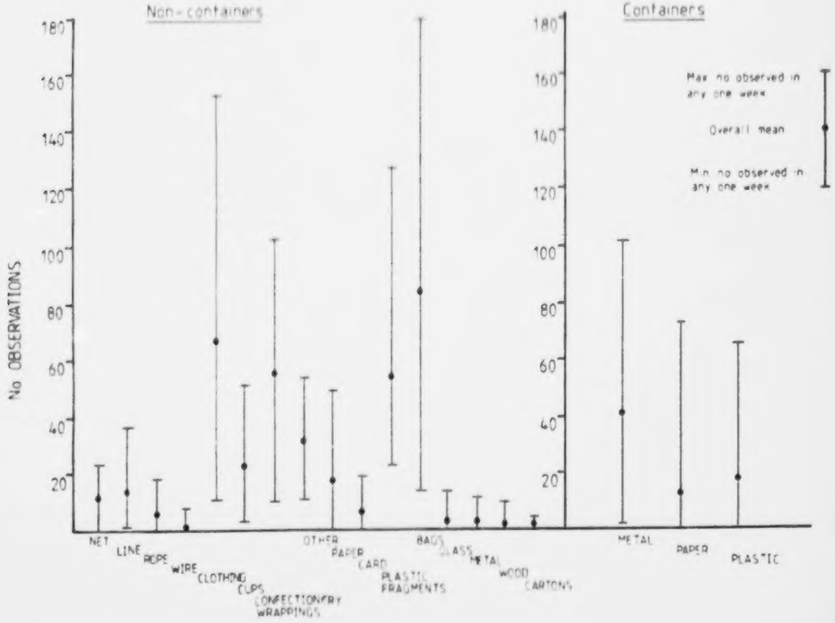


FIG. 2 - TOTAL LITTER (percentage composition)

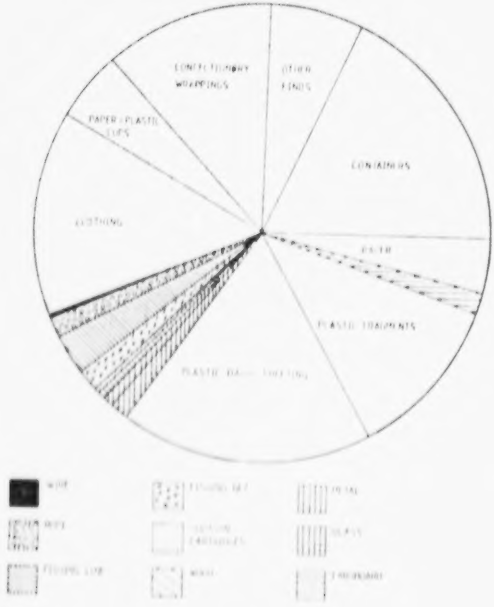


FIG. 3 - CONTAINER LITTER (percentage composition)

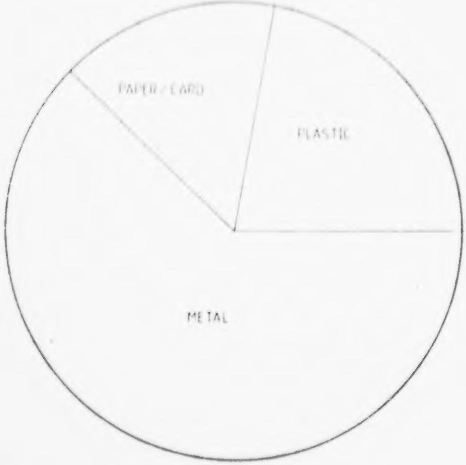
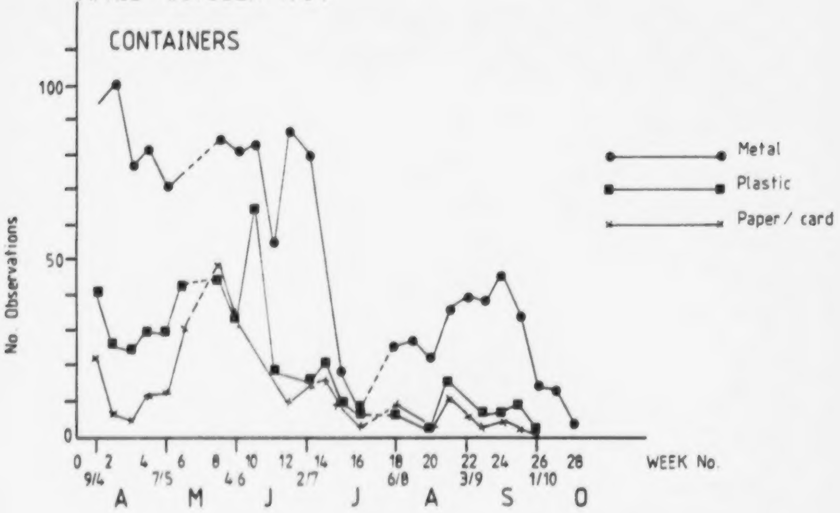


Fig.4

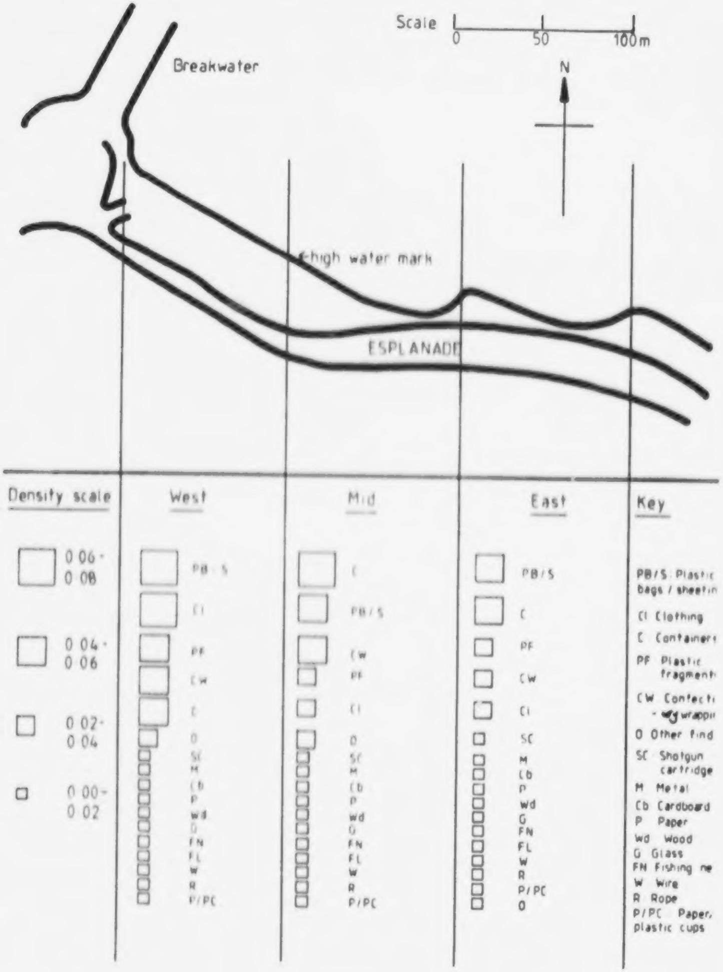
LITTER ON THE BEACH AT CRAMOND, EDINBURGH
APRIL - OCTOBER 1984



The post clean-up pattern of the litter, follows that of the earlier part of the study, only at a lower level of incidence. The spatial distribution of the foreshore litter (Figure 5 was determined along transects from which a Density Index was calculated, so that the pattern of litter deposition of each of the categories could be seen. It is obvious that the pattern of tidal movement approaching the breakwater resulted in the floating debris being deposited in increasing concentration westward as the tidal margin curved landwards when the breakwater was reached.

Maritime litter pollution, on which the Cramond study has shed a local spotlight, has received increasing (though by no means considerable) attention in recent years). The studies of Trevor and Joy Dixon in the English Channel area have pioneered British work on maritime pollution. (Dixon & Cooke, 1976; Dixon & Dixon, 1981). Their attention to this problem has more recently taken them to the North Sea (Dixon & Dixon, 1983).

FIG.5 - Density and distribution of litter



CONCLUSION

As Cramond is one of the most frequented beauty spots of the Edinburgh coastline, receiving tourists and visitors from both the U.K. and overseas, this study of its litter seemed both justified and urgent. At the Cramond Heritage Trust Exhibition in 1984 (open Saturdays and Sundays during June and July), some 2,787 visitors signed the Visitors' Book - of these, 131 were local, 1,116 were from the Edinburgh area, 630 were from elsewhere in Scotland, 355 from other parts of the U.K. and 370 came from overseas. This microcosm of tourist interest in Cramond was faced with the litter described, which represents an unacceptable face of Edinburgh.

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THE HISTORY OF MAN-ENVIRONMENT INTERACTION

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INTRODUCTION

Many geologists are concerned with divisions of time. One of their principal tools is stratigraphic analysis. This paper examines such methods as applied to the most recent geological period in the British Isles and discusses the question 'for how long has man had a significant impact on his environment?'.

The present geological period is known as the Quaternary and has occupied approximately the last two million years. Many Soviet workers have suggested the substitution of the term 'Anthropogene', arguing that the Quaternary roughly corresponds with the evolution of hominids; in other words to use faunal evidence to define geological time (Gerasimov, 1979). However, such a proposal has not found international favour and the present authors use the term 'Anthropogene' in a much looser way, not to identify a fixed period of time, but to refer to that most recent part of the Quaternary for which there is evidence of man's impact on the environment. Even within the British Isles this period of time is clearly of differing duration dependent on the establishment of populations and the diffusion of technology. This use of the term 'Anthropogene' also begs the question: what level of man's activities are necessary before a truly natural environment (i.e. without the influence of man) ceases to exist.

Such issues can be much more ably addressed than they could be a few years ago as a result of newly devised techniques of resulting from the upsurge of Quaternary studies since the 1960's and also as a result of more accurate dating techniques which enable a valid chronology to be placed on the history of man-environment interaction in the British Isles.

Some Quaternary perspective is a useful backdrop to this review. The Quaternary is sub-divided on the basis of climate. It is characterised by alternating relatively warm (interglacial) and cold (glacial) stages. Some of the cold stages in the British Isles were associated with glaciation. Throughout the Quaternary at least 17 oscillations from cold to warm conditions can be recognised (Bowen, 1978). Yet for much of this time there is no evidence for man in these islands. The earliest clear evidence comes from a cave site at Westbury-sub-Mendip where primitive flint tools were found in cave sediments of Cromerian age - about 300-350k years before the present (BP). The earliest direct evidence of man in the form of a human skull, was found in the lower Thames valley at Swanscombe in deposits representing the end of the Hoxnian/start of the Wolstonian

(Wymer, 1981) - about 200k BP. Such early evidence of man in the British Isles is relatively rare and during succeeding glacial phases, much of Britain was covered with ice, with conditions too cold even in ice-free southern Britain for any significant impact by man on the environment. On this time scale, the pronounced climatic changes and their effects on the environment are the dominant feature. It is only within the interglacial in which we are now living, the Flandrian Stage, that man assumed much greater importance as one determinant of environment in these islands. Undoubtedly the classic work on establishing the beginnings of the profound vegetation changes which took place at the hand of man has been achieved using the technique of pollen analysis. It is perhaps fitting to pay tribute at this point to the pioneering work of Sir Harry Godwin who died recently. His work and that of his students and colleagues has given us a wealth of data on the changing history of the British flora (Godwin, 1977, 1981). His model of pollen zones still represents a useful summary of events even if detail varies from site to site within the British Isles. (Figure 1). Indeed the boundaries between the Godwin pollen zones VIIa/b and VIIb/VIII are largely drawn on the basis of changes in the vegetation mix attributable to human interference.

In order to shed light on the anthropogene this paper reviews three areas of palaeoenvironmental enquiry which utilise stratigraphic information as examples of approaches to discover the timing and extent of man's impact on his environment.

POLLEN ANALYSIS AND BIOSTRATIGRAPHY

Pollen diagrams allow reconstructions to be made of the relative changes in vegetation cover, one of the environmentally most significant indicators. Yet the fundamental question to be answered is whether the deforestation that is almost universally recognised in the British diagrams of the Flandrian stage was the result of climatic change or Man's activities. Writing in 1956, Godwin observed that, 'in its present state of development pollen analysis is unable to decide whether forest clearance in Britain was essentially climatic in cause or anthropogenic'. Subsequently, however, numerous palynological investigations have identified certain trends in the pollen diagrams:

(a) A general decrease in the pollen of certain tree species at 5k BP.

(b) An increase in Plantago lanceolota (ribwort plantain) and those of other ruderals and weeds indicative of open, disturbed and perhaps cultivated ground.

(c) Selective deforestation is also apparent at around this time involving Tilia (lime and Ulmus (elm). Both species prefer good soils and their foliage may have been used for fodder.

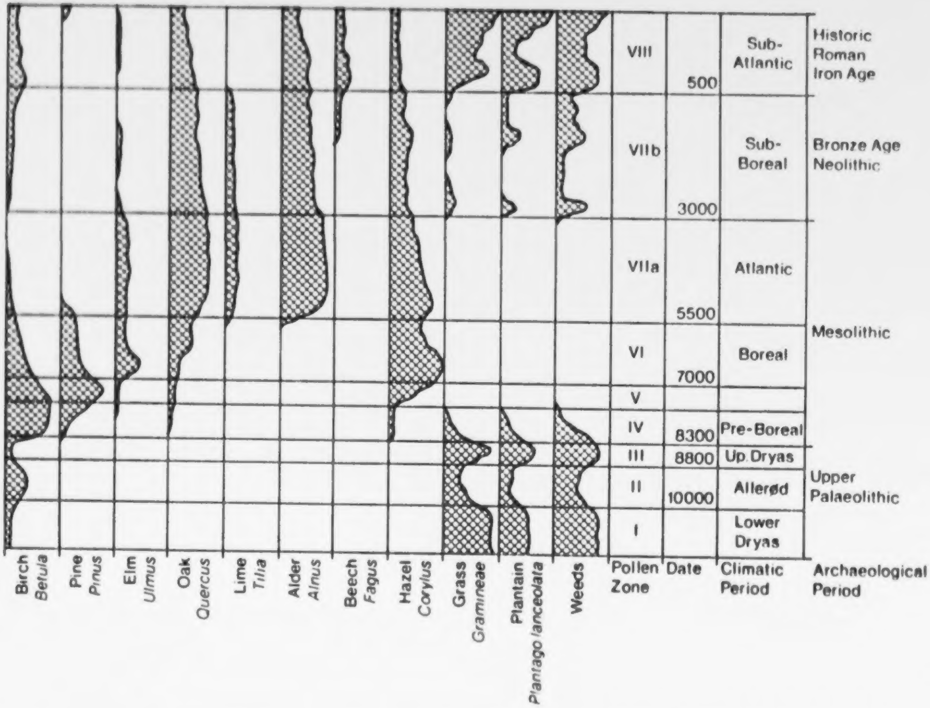

Figure 1 Generalised Pollen Diagram for Pollen Zones I-VII in England (after Godwin, 1956)

Amongst many workers to observe these trends, Durno (1965) examined some Scottish sites where evidence of landnam (literally 'land take') was found. An important characteristic of one of these sites (Dalnaglar at 330m OD.) was partial forest clearance alternating with regeneration, possibly due to slash and burn techniques. Accurate dating for these events was not available. O'Sullivan (1974), working in Speyside, used radiocarbon assay to date the beginnings of clearances in the area. A peat core from Lock Garten yielded a date of 3635 + 205 BP to this forest clearance. At this time, Pinus (pine) markedly decreased whilst heathland species and ruderals became more common. O'Sullivan considered that the Clava group of chambered tombs quite common in Speyside may have been constructed at the same time and by the same people responsible for the forest clearances.

Turner (1962) also used radiocarbon assay to date vegetational changes deduced from pollen analysis. This relatively early work was centred on Shropshire, Somerset and Yorkshire and examined the decline of Tilia. Anthropogenic influence is again demonstrated by an increase in ruderal pollen associated with a consequent decline in arboreal pollen. Although climatic change must be considered to have played a minor role in this, Turner argues that it may have influenced the activities and distribution of human settlers and therefore their effect on the regional vegetation. Radiocarbon dates at the three sites show that the Tilia decline occured at different times in different regions, reflecting perhaps the influence 'of at least three distinct prehistoric cultures'. This would mitigate against the climatic theory for the Tilia decline. It is interesting to note that Tilia never regained its former status. A combination of edaphic and anthropogenic factors is probably responsible.

More recently, Sturludottir and Turner (1985) have argued that there is probably no single explanation for the decline in tree pollen at about 5000 BP and 'that we should instead be seeking to understand it on a site to site basis'. Their work examined the Ulmus decline at Pawlaw Mire, a site at 462m OD in the Northern Pennines. A peat core had thin samples (1mm thick) taken from it to allow pollen changes to be identified woodland at the site consisting largely of Quercus (oak), Betula (birch) and Ulmus. Above this, the pollen of ruderals and weeds indicative of more open woodland increased and this, associated with the presence of charcoal fragments, led the writers to postulate that fires had caused the change to open woodland. Such fires were probably the result of Mesolithic man's attempt to provide browse for wild animals. Arboreal pollen frequencies rose until the level of the Ulmus decline when a small number of pollen grains indicative of farming practices appeared, suggesting that Mesolithic woodland management was the probable cause of the Ulmus decline in the area. On the basis of other North Pennine sites, it is considered that the Ulmus decline occured at around 5407 BP.

PALAEOLIMNOLOGY

Palaeolimnology is concerned with the analysis of lake sediments. Pennington (1981) has stated that 'the lake ecosystem is one which leaves, in its sediments, an unusually full record of its life through time. The record is written in codes; palaeolimnologists try to crack as many codes as possible, by analysing sediments for a wide range of physical, chemical and biological variables'. Oldfield (1977) has outlined some of the potential of this approach, and several studies have demonstrated how conclusions can be drawn which relate to man's impact. The technique requires the recovery of sediment cores from the beds of lakes, sampling of those cores and if possible dating to provide a temporal framework. Both the quantity and quality of the influx of sediment to a lake is sensitive to major impacts by man. Recent work at Llangorse Lake in Wales has shown the variability through time of sediment accumulation (Jones et al, 1985). This increasing rate of transfer is interpreted as the effect of human activity. It is possible to identify three broad phases of sediment input:

(a) Pre Ulmus decline, 9000-5000 BP, where 'natural' rates prevail - less than 5cm/100a.

(b) 5000 BP-AD 1840 - about 15cm/100a. This represents the first major disturbance of the vegegation cover of primary forest. Such evidence for perturbation in the environment and an increase in sediment rates is common in other British lakes at this point.

(c) Post AD 1840 - about 60cm/100a. These much higher rates can possibly be attributed to the expansion of cereal farming on marginal land.

The sediment chemistry at the point of the Ulmus decline shows a peak in carbonate levels which represents leaching of soils at the point where pollen levels show a strong increase in non-aboreal pollen: good evidence for forest clearance. Further, the increase in the rate of sedimentation at this point may be attributable to stream erosion of mineral soils following an increase in streamflow consequent on deforestation.

It is interesting to note that the increase in the rate of sediment accumulation in English lakes at the time of the Ulmus decline is similar to the observed increase in the sediment load of streams draining an experimentally deforested catchment in the Northeast US which was monitored before and after deforestation (Likens et al, 1970).

PALAEOHYDROLOGY

Thirdly we can consider the potential of fluvial sediments to enable palaeoenvironmental reconstruction. Borehole data on floodplain sediments can yield information on the changing river regime, a foodplain sediments can yield information on the changing river regime, a factor which is sensitive to human impact. Several authors have commented on the existence of a surface inorganic unit on floodplains in lowland Britain. This has been dated relative to organic sedimens and has been viewed as evidence of late and post Neolithic agriculture and deforestation. Brown (1983), for instance, has noted that the major palaeohydrological characteristic of the Flandrian in the Severn basin was an increase in fine sediment output.

Two case studies will be mentioned. Firstly, Harvey (1974) and Harvey et al (1981) have noted the presence of both active and inactive erosional gullies cut into Quaternary sediments on steep slopes in the Howgill Fells of Cumbria. These gullies are the erosional parts of sediment systems and the material transported from them can be identified as forming stream terraces and alluvial fans and cones lower down the valleys. Radiocarbon dates from organic sediments and related to these fluvial landforms and pollen analysis from nearby peat sites have provided evidence to support a link between woodland clearance and associated farming practices and the initiation of gully erosion (Cundill, 1976). Clearance phases have been demonstrated during the Bronze Age at 3480 BP, the Roman period at shortly after 2290 BP and the Norse period.

The second case study involving palaeohydrological systems is taken from the contrasting landscape of Southeast England. Burrin (1985) has investigated the floodplain of the River Ouse in Sussex to evaluate the extent of anthropogenic control on sediments and land forms. His findings show that the Wealden iron industry which reache its peak during the fifteenth and sixteenth centuries seems to have had minimal effect - no evidence of iron working waste being found within floodplain sediments, strongly indicating a lack of recent floodplain construction. Analysis of the sedimentary fill beneath the floodplain at Sharpsbridge has shown a clear stratigraphy. The age of each sedimentary unit is indicated by the pollen which it contains and has allowed a schematic diagram showing episodic deposition and erosion to be constructed. (Figure 2). The increases in sediment supply responsible for the phases of alluviation are ascribed to anthropogenic deforestation within parts of the catchment since at least Neolithic times, possible even earlier. These findings demonstrate that there is not necessarily a clear relationship between climate, hydrological regime and floodplain construction.

These case studies, selected from a rapidly burgeoning literature, have hopefully given an indication of the status of palaeoenvironmental enquiry with respect to anthropogenic influences. The

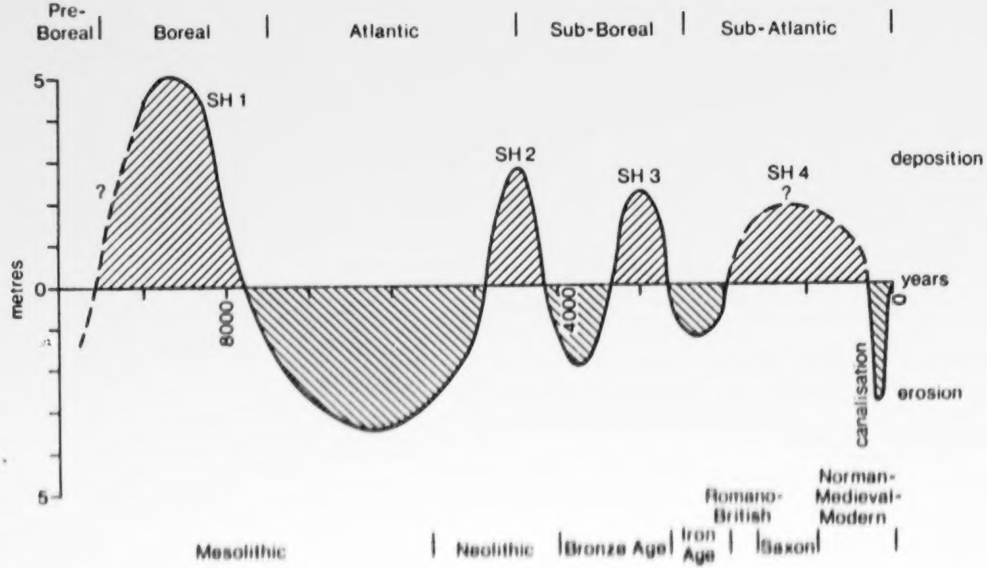

Figure 2 Schematic diagram showing episodic alluviation and erosion during the Flandrian at Sharpsbridge, Sussex Ouse (after Burrin, 1985)

present authors would claim that such a perspective is a valid one for environmental studies. Looking at the extent of man's impact on past environments does involve addressing the processes by which environmental change operates as well as reminding us that the environment with which we are familiar in this country - even in the remoter upland areas - is far from 'natural'. This clearly has implication for conservation; exactly what are we conserving?

One recurrent theme of this review has been deforestation as a process whereby man profoundly changed the natural environment. Any methods of environmental reconstruction can only give a partial view of man-environment interaction in the past. For instance, it is often difficult to assess the extent of deforestation on the basis of lake sediments or pollen data. It is in such fields that the study of contemporary environments can both inform palaeoenvironmental analysis and be illuminated by it. The Anthropogene is a reality and its study can greatly contribute to a rounded environmental education.

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VALIDATING ENVIRONMENTAL DEGREES

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INTRODUCTION

This anecdotal paper presents a validator's perspective on factors relating to academic rigour in environmental courses. It looks at the general problem of validation of courses in higher education, the intention being to produce a clearer perspective of what is required. It is very much a personal viewpoint, based on the experience of the authors as members of the Council for National Academic Awards' Environmental Studies and Geology Board. However, this is a perspective on problems and practices of validation as seen from both sides of the fence as both authors have had as much experience being validated as being validators!

The question of Academic Validation is of concern at all levels, a concern which has culminated in the recent Report of the Committee of Enquiry into the Academic Validation of Degree Courses in Public Sector Higher Education (1985). This report - the Lindop Report - has been the subject of much debate, and it is a matter of widespread regret that the Lindop Report concerned itself only with public sector colleges and not with Universities. However, this paper is not concerned with the wider political implications of the validation exercise, except to note that the process of peer group review in one form or another is here to stay.

Peer group review is the common feature of higher education course validations, either bureaucratic, structured and formalised as with the CNAA, a concept emphasised/encouraged by the CNAA itself through its declared policy of partnership in validation (CNAA, 1985), or more informal and less structured as is frequently the case within Universities. The author's experience as external moderators is primarily with the former system. Validators in either system are faced with having to ascertain to what extent assertions of fact and intention by course teams in their documentation are actually borne out in practice. We are all familiar with the possible discrepancy between these two phenomena, and the validator's job is to seek evidence that course teams are able to do what their submissions claim they are attempting to do. Only at this point can proper and informed decisions be made relating to the academic standing of courses, departments or colleges.

VALIDATION CRITERIA

The Council for National Academic Awards lays down succinct principles for the award of its first degrees and Diploma of Higher Education. The Business & Technicians Education Council (BTEC) does likewise. No doubt University Senates have similar principles. For reference purposes, readers should refer to the CNAA Handbook (1985, p 21-29). This gives a formal statement of what is required and is an appropriate yardstick for evaluating academic rigour in higher education courses. If such a yardstick was more widely known and used there would probably have been no call for this paper!

Some general points need to be made concerning basic principles:

1. Diversity of Tradition

   There is a diversity of tradition, of custom and practice, in higher education and this is no more so than in environmental education. Innovation is always welcome, but it has to be a rational innovation and not speculative, self-indulgent, anarchic or devoid of discipline. It has to have a point. Aims, objectives or intentions have to be defined clearly but must relate to the knowledge and experience of staff teaching to them.

   What emerges from the above is that there can be no prescribed model.

2. Institutional Context

   Under the CNAA system, a course which receives approval as having appropriate academic rigour will not be seen again by the CNAA for five years. Until then the college becomes responsible for the continued running and development of the course. That is why the institutional context is so important, and that there have to be appropriate course management and control procedures. In other words, *means* are as important as *ends* in order to maintain a continuity of standards. This scrutiny on the part of the CNAA, however, should not be regarded as a purely negative function. Indeed, course teams often benefit from the support of the CNAA in obtaining staffing and physical resources from somewhat reticent institutions. Thus provision of such resources is frequently a condition of validation of many degree courses by the CNAA.

   With a continuous, informal peer review exercise, as practised by many Universities, the situation is different and it becomes necessary only to ensure rigour and external moderation of the exercise. However, it is here that we encounter one of the Catch 22 situations, regarding external moderators, as in the early days the only accredited people were in the University sector. Whilst this is perhaps no longer true of External Examiners, it is still very much the case in terms of research student supervision; Principal Supervisors must have had prior successful experience of research student supervision. Yet how can that experience have been gained in the first place?

3. Programme of Studies

Any programme of studies must relate to the aims and objectives and must have an appropriate balance, progression and coherence. The range of intentions in environmental courses can be wide.

i) Preparation of a particular profession of vocation (e.g. Environmental Health - see papers presented elsewhere in this Conference by Cusack & Wood (1985) and Kliger, Chambers, Parkinson & Carter (1985).
ii) Preparation for employment in industry, commerce and/or government.
iii) General education.
iv) Development of general problem-solving skills.
v) Development of artistic/creative skills.
vi) Development of understanding of breadth of subjects.
vii) Development of understanding in depth.
viii) Development of interdisciplinary coverage.

Most undergraduate environmental courses, other than Environmental Health, tend to embrace elements of iii-viii, whilst postgraduate courses are more strictly geared to ii.

The academic rigour should ensure that intellectual and/or imaginative skills and powers are developed, rather than the mere acquisition by rote of knowledge. The emphasis should be on explanation rather than description leading to a greater degree of understanding and competence. Acquisition of knowledge/skills is only valid if leading to a higher level of intellectual/creative performance in terms of, for example, analysis or synthesis.

The programme of studies should stimulate powers of enquiry, analysis, creativity, judgement and critical self-awareness. The roles and balance of communication and numeracy skills need to be addressed.

These are all established aspects to anyone familiar with CNAA documentation and procedures, but are worth re-iterating. These must all strike a chord with those concerned with environmental education as the scope offered is tremendous if properly harnessed.

This diversity can perhaps be best illustrated by means of a few examples of definitions of environmental science/studies as found in a number of (unnamed!) course submissions:

i) B.Sc./B.Sc. (Honours) Environmental Science
This is a three year full-time degree. It is a problem orientated, holistic interdisciplinary course, with a rationale based on the 'environmental crisis' conflict between a rising populations demands on finite resources. The course aims to produce environmentalists - in fact,

about 1/3rd of the graduates go on to post-graduate/post-experience study. The broad base of the course enables graduates to progess to more specialised and discipline-based work. The course is based on a broad science spectrum from which students can select specialised aspects. The Honours scheme has a project.

ii) B.Sc./B.Sc. (Honours) Environmental Studies
This is a four year thick sandwich course. The course emphasises the interaction between physical, biological and social aspects, with particular reference to utilisation and management of resources. There is less formal emphasis on 'hard' science compared to the Environmental Science course described above, more emphasis on planning/economics/social aspects.

Honours scheme has more material included, plus a project.

iii) B.A. (Honours) Environmental Studies
This is a three year course, with a general educative philosophy using environmental issures as a focus. Principal themes are elements of the environmental system, social, biological, physical, economic, geographical, and man's interaction with these elements. Relatively speaking, the course lacks a 'hard' science core, the emphasis being on integration and the holistic approach.

There are significant inputs of law, politics, planning and economics, but no scientific disciplines as such.

iv) B.Sc./B.Sc. (Honours) Environmental Studies
This course has a catholic integrative holistic approach. It is very 'open-ended'. There is a little discipline orientation. The course has no pretentions to being anything other than a stimulating, personal, educative experience.

Honours scheme has a project.

v) B.Sc./B.Sc. (Honours) Science and the Environment
This course is seen as appropriate for subsequent M.Phil/Ph.D. work in a wide range of disciplines.

It is a four year sandwich course, very science orientated but with an environmental 'umbrella'. It has a biotechnological stream, reflecting the modernity of approach. Emphasis is on interrelationships between sciences and the environment, but with a distinctive concern with social aspects.

vi) B.Sc. (Honours) Environmental Health
A four year 'thin' sandwich course with a strong vocational flavour - the intention is to produce environmental health officers who will work in the main in local government. The course is science and technological based within a strong legal/social/economic/planning/framework.

The course produces graduates who are practitioners within the fields of public health and pollution control in their broadest contexts.

4. Level of Studies and Type of Award
The level of studies and type of award need careful consideration:

Diploma in Higher Education	) Environmental Health
B.Sc./B.A./B.Ed.	) Environmental Science(s)
B.Sc.(Hons)/B.A.(Hons)/ B.Ed. (Hons)	) Environmental Studies
Post Graduate Diploma	) Science and the Environment
M.Sc./M.A.	) Specialist environmental issues (e.g. pollution; resources).

There are clear expectations of attainment based on assumptions of entrance qualifications. The programme of studies needs to reflect the type and title of award. For example, the Dip.H.E. is much of an unknown quantity; to be sure, it frequently serves as a stepping-stone to a degree, being equivalent to the first two years of honours degree level work, yet is still almost entirely unrecognised as a qualification in its own right; even the CNAA Dip.H.E. Certificate omits to state the subject of the Diploma!

ENVIRONMENTAL COURSES

The environmental ethos shows itself in either multidisciplinary courses or interdisciplinary courses. Environmental issues are not single discipline-based, and a proper understanding of environmental issues dictates the need for integration of subject areas and disciplines. Appropriate environmental sciences need to be put into a broader socio-politico-econic and/or legal context. This is one of the keystones of environmental courses, and the rigour of undergraduate courses has to be seen in this integrated context. The mechanisms for integration need to be clearly understood and effectively operated. Integration has to be a student-centred exercise - it is part of the education experience to which students are subject and a key element of academic rigour. There are numerous integrating exercises that can be utilised - e.g. presentation of interdisciplinary seminars, projects, case studies, industrial (sandwich) training. However, it would be unreasonable to expect all the integration to be the responsibility of the student, practical example has to be set by staff. Tutors on courses need to demonstrate an awareness of how their particular discipline interface with others in an appropriate environmental context. Their approach should reflect an awareness and appreciation of the many facets of environmental work. Whilst not expecting all tutors on environmental couses to be 'environmentalists', there should be a core of such tutors providing the appropriate coherence and guidance.

Environmental science courses need to demonstrate a rigour that is based also in the complexity of principles of physical, biological and/or earth sciences brought to focus through appropriate environmental issues. These issues may be resource orientated and/or pollution orientated. The complexity of environmental systems is well demonstrated by the development of ecosystem modelling, only made possible with the advent of the new generation of computers and the accumulation of a massive database from the many contributory disciplines to environmental science. Perhaps it is this last point, that of the environmental scientist being something of a 'chartered libertine roaming at will over the legitimate preserves of ... established and respected disciplines". (MacFadyan, 1957) that potentially makes the (mostly) disciplinary judges of environmental courses so critical.

Set against this pattern of the more generalist, academic nature of Environmental Science/Studies courses, Environmental Health courses are very vocational. These courses are science and technology based, but within a legal, social, administrative and economic framework. Integration of subject material is crucial, whilst recognising the constrained view of public health and pollution issues.

The level of environmental courses is complicated by their multi- or inter-disciplinary nature. Whilst Environmental Science/Studies do not appear to be seen as a 'soft option' in schools, (Gayford, 1984a) the subject continues to be regarded as less rigorous than single-discipline subjects as evidenced by its lower acceptability as an 'A' level subject for University entry (Gayford, 1984b). Such an attitude undermines the academic standing of the subject. We would argue that it takes a greater breadth of intellect and depth of perception to be able to appreciate the holistic nature of environmental issues, and to be able to draw upon the diversity of subjects which impinge upon those issues. It also helps explain why relatively few people pursue environmental science/studies at 'A' level, yet environmental courses are very popular in Higher Education. Considering the small proportion of school leavers who go on to higher education, it could be argued that preparation for (non-academic) life could well be acheived through environmental education for all school pupils rather than the continuing emphasis upon specialist subjects. To return to environmental education at H.E. level, such studies should be recognised as being more demanding than a course in one of the contributory disciplines. Furthermore, the range of study skills called upon in environmental education is very broad, and therefore develops and enhances intellectual and practical skills in a way that is not usually found in single disciplines.

Recognising that the entrance qualification and/or prior experience of students coming onto environmental degree courses is broad, the need for foundation courses which level out and broaden the knowledge and understanding of students is therefore a crucial component of the academic rigour of undergraduate environmental courses. A curriculum devoid of balancing studies may necessitate a very constrained programme or dictate a very narrow spectrum of intake. Neither of these would be desirable in the environmental context, which is essentially broad and catholic. The issues is even more complex for postgraduate courses, which may be conversion or specialist, and catering for a very wide range of graduate intake.

The team of tutors teaching an environmental course need to be very clear in their view of the level of the course and should be able to demonstrate with conviction how a particular course goes beyond, say 'Advanced' level Environmental studies, or graduate studies in Environmental Studies/Sciences. This view should go beyond the level of expectation and attainment of students on a course, and be reflected in the course content and its treatment. And then there is the problem of defining how much science goes into an Environmental Science or Studies course, with no accepted figure for what the balance should be; nor can there ever be, given the diversity of structure and content of the current courses.

THE REALITIES OF THE PROCESS OF VALIDATION

Peer group review is not an exercise in mutual back-slapping. Or at least it should not be - it certainly isn't with the CNAA. It is worth repeating that the role of validators is to seek evidence supporting assertions of course facts and intentions. As a peer group review exercise this is frequently forgotten or misunderstood, and legitimate comment and criticism is frequently subject to personalised over-reaction and not accepted in a proper professional manner. All of us will be familiar with the often vitriolic private and public reaction to which we refer.

So who validates the validators? Frequently-voiced criticism fails to consider:

(a) the specified (and sometimes statutory) duties and responsibilities of validating bodies;
(b) the prescribed procedures for validation;
(c) the consultative nature of the exercise and the right of appeal;
(d) the participatory role of the institutions who are able to nominate candidates for selection by the CNAA to serve on their various panels and boards.

The validation exercise is not intended to be adversarial although it is all too frequently seen as such by those being validated. It has to be said that there have been 'bad' validations, and there are inadequate and unprofessional validators, but the vast majority of such peer group exercises are carried out with the best and most professional of intentions and practice. It is peer group review which keeps scientific research (and other scholarly activities for that matter) accountable and educational activites would be the wores without such review. The need for dialogue is paramount and those being validated have the right to challenge the credentials and credibility of validators as well as the professionalism and objectivity of the validation exercise.

The approach adopted by most validating bodies is to consider assertations relating to aims and objectives content and treatment, level of course, course management and college environment etc., and then to seek appropriate evidence in documentation and/or review visit. The yardsticks are quite explicit, and some examples of approach can be instanced.

i) Aims and Objectives
Are these reflected by what the teaching team say and do?
Do students perceptions of an established course to date support achieving of the aims and objectives by agreed means? (Indeed, are there mechanisms for obtaining student's perceptions?).
Are aims and objectives reflected in the subsequent achievements of the graduates?
Does the course content and treatment reflect the aims and objectives?
For vocational courses (e.g. Environmental Health), do appropriate professional bodies and/or employers accept that the aims and objectives are appropriate and are being achieved?
Are these people adequately consulted by the course planning team in the first place?

ii) Course, Treatement, Level and Type of Course
Can the course team talk coherently about the level of their course?
Can they explain clearly how a Dip.H.E. or a degree course goes beyond 'A' level? Or how a Dip.H.E. differs from a degree, or a degree from a degree with honours?
Or how a P.G.D. differs from a first degree?
Or how a Masters course relates to a first degree and/or P.G.D?
Is there a clear progression in the coruse and can this be demonstrated in the syllabuses, for example, or in the examination questions?
Is the reading list appropriate?
Is it up-to-date, relevant, and accepted as an appropriate level compared to custome and practice elsewhere?

What coursework topics are set? Are there examples of integrating exercises (if appropriate), field course work, laboratory work?
What type of projects can be demonstrated?
What sort of examination questions are set, and what are the mark/answer schemes like? External moderation (another form of peer review) should be the norm, and the views of the external moderators on student performance are crucial.
What range of pedagogic skills are brought to bear?
What are the experience and qualifications of the tutors on the course?
Are they appropriate?
Is appropriate staff development taking place?
What research, consultancy, scholarship or other appropriate professional activities are undertaken to support the course?
Is there demonstrable innovation, enthusiasm and commitment?
In the environmental context, is there an appropriate range of subjects/disciplines?
Is the balance of subjects/disciplines appropriate for the course title, aims and objectives?
Can the course team justify the course content and rationale?

iii) College Environment

Assessments of physical facilities, library stocks, audio-visual and related technology, ancilliary support are all relatively straight forward exercises.

Factual information on academic structure is also straight-forward although the effectiveness of its functioning is an altogether more complex issue.

Course management is easily clarified. Do clear leaders of years or subjects emerge to act as foci for monitoring and developing the course?

The issue of staff commitment to Environmental Science/Study courses is an important one; it is usually immediately apparent on any validator's visit whether the course tutors represent a coherent group of individuals committed to the idal of holism, or whether at the other extreme they have been individually dragooned in from other areas of single-discipline commitment. Such differences can radically affect the reality of how a course holds together, no matter how elegantly designed the structure and content.

There are many other issues which could be addressed.

Now that we are well into the second decade of Environmental Education at tertiary level, it is worth noting the general world scene against which these course developments have taken place. It is a world which in the 1960's saw the rise of the ecodoomsters (Goldsmith, 1972) through the energy crisis of the 1970's (Meadows, et al 1972) and into the 'new wave' of ecological awareness in the 1980's (e.g. Brown, 1981). Have environmental courses followed a similar path of development and change, from the more frenetic to the more reflective? Has the publicly more acceptable face of environmentalism meant that Environmental Science/Studies has come of age or even become part of the establishment? Or is it still the 'subversive science' it was perceived to be in the 1960's? Perhaps the latter still holds true, as the current attitude of the U.K. government is that such courses serve no useful purpose in terms of the economic recovery of the country, culminating in the assignment of environmental education to the 'unprotected course area' by the National Advisory Body for Public Sector Higher Education.

Perhaps the most disappointing aspect of CNAA validator's experience over the last five years has been the almost total lack of new environmental courses; most validation exercises have been revalidations. Such a state of affairs is unfortunate for any subject area, as innovation tends to be damped and dynamism curtailed. However, such is the shrinking pool of higher education support, that such factors are affecting many other disciplines.

It is also of interest to note that in the UK there are few Higher Education environmental courses for technicians. Perhaps this reflects the skill emphasis traditional in technician work, and the fact that the value of environmental courses emerges as a result of integration of ideas and concepts as much as with skills. It may also reflect the lack of an organized, structured professional body of 'Environmentalists' (Environmental Health Officers excepted), and the consequent lack of professional and technical hierarchies, standards and status.

In presenting this paper the authors have tried to avoid an idiosyncratic approach to environmental courses. An overview has been presented in an attempt to bring into sharper focus the most commonly encountered issues in the validation of environmental courses. These are all common sense mainstream issues which are frequently given insufficient throught and time prior to validation.

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WRITING BOOKS FOR ENVIRONMENTAL EDUCATION

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INTRODUCTION

If science is defined as knowledge of the environment, then most science books could be said to contribute to environmental education, and so could many books recording the observations of people who would not consider themselves scientists. I shall refer to some books written specifically to influence the way people think about the world in which we live, and consider the questions: Who is to write books for environmental education and who is likely to read them? What difficulties have faced writers in the past when they had something new to say, and what difficulties face writers now if they say things that conflict with current beliefs?

BOOKS FOR ENVIRONMENTALISTS

Most teachers of environmental sciences, in higher education, have qualifications in biology, chemistry, economics, geography .... They have administrative and research as well as teaching duties. As a result of the pressure of work they are most likely to read only those papers and books that are most relevant to their particular research and teaching interests. They are likely to recommend similarly specialised reading to their students.

Most teachers in higher education, if they write books for environmental education, will feel best qualified to write academic books related to their own specialised teaching and research interests. There is a need for such books. They are read by the relatively few teachers in higher education who have these specialised interests; and will be consulted by many other teachers with related interests. They will also be used by students. That is to say, such books are useful to those who are already interested in the environment.

Because teachers of environmental sciences in higher education teach only part of any course, only students can experience the course as a whole. Some teachers will help their students to make connections; and even specialist books can help to do this. Introductory and concluding chapters, especially, can put a specialisation into a wider perspective - by referring, for example, to economic applications or social implications.

However, students need other less specialised books for background reading. Such books can help to make connections, present arguments, or draw attention to different points of view. I am not suggesting that textbooks of environmental science are needed. On the contrary, with a variety of courses, and with choices of subjects or modules within each course, it would be impossible to write one general text for all students - even if this were desirable.

Less specialised books are most needed by readers who have an interest in the environment, and to create interest in others. Books for environmental education are needed most by those people who are not taking degree courses in environmental science. Most people do not take such courses. At school, pupils who intend to make a career in science or engineering will probably select subjects for study from biology, chemistry, physics and mathematics; and most of those who do not wish to make a career in science still study no science after the age of sixteen.

There are many books for students of environmental science - who are prepared to seek information and who do not mind too much if a book is hard going. Also, students usually have people to help them - by answering questions and helping to make connections. It would be unfortunate, therefore, if specialists on aspects of environmental science, teaching courses in environmental science, were to write only for environmentalists. There is a more urgent need to interest people who are or will be leaders in various careers.

BOOKS FOR ENVIRONMENTAL EDUCATION

In an article on The Two Cultures published first in the New Statesman in 1956, C.P. Snow emphasised the need for a greater public awareness of science. He suggested that many of those who take decisions in our society know very little science. They consider uneducated those scientists who display a lack of knowledge of the imaginative literature of our past, but do not consider their own ignorance of the science of today as an indication of a lack of education.

Snow was confident that this division would be remedied by changes in the school curriculum. But thirty years later this has not yet happened. Children at school still have a choice of subjects which permits some of them to abandon a broad study of science at an early age. Also, there are many science teachers in schools who because of their own specialist training think of themselves as biologists, chemists or physicists rather than as scientists. They feel unqualified to teach a course in general science even for first examinations taken at the age of sixteen.

Another consideration, if all people are to receive a balanced education, is the need to reduce rather than increase the choice of subjects available in schools. Pupils who take three science subjects up to the age of 16+ (for example, biology, chemistry and physics) are getting too much science if their study of these subjects means that they cannot study others (including literature, languages, geography and history). Pupils who study only two science subjects (for example chemistry and physics) receive an unbalanced introduction to science, and pupils who study only one science subject (for example biology) are ill prepared for life in the world of today and tomorrow. A case can be made, therefore, for encouraging new courses in integrated or general science - taken by all pupils up to the age of 16. Environmental science, however, does not provide an alternative to such a general science course unless the word environment is interpreted so widely that this becomes a general course in science.

Consequences of having school subjects called Environmental Science, with examinations taken at 16+ or 18+, are (1) that people write books to cover material included in the syllabus, and (2) that for pupils, an interest in the environment instead of providing a link between school subjects becomes a subject in its own right. It is a specialisation which some pupils take and which, therefore, some do not. This is regrettable because environmental education is necessary for all. Like the teaching of language and health education, environmental education should be spread across the curriculum - for example, as part of courses in literature, history, geography and integrated or general science (see papers by Aho and Williams in this volume). Interest in the environment should also be encouraged through varied leisure and recreational pursuits.

The challenge for authors of school textbooks, in all subjects, is to write in such a way as to interest their readers. They can do this by showing the relevance of each subject to everyday life - and particularly to the pupil's own life. Appropriate references to the environment can help to make each subject more interesting. I conclude that textbooks for most school subjects could and should contribute to environmental education (see, for example, Barrass 1981 and 1982) and that environmental science should not be a separate school subject.

The opportunity to interest children in the environment should be taken whilst they are at school. Young people are receptive to new ideas and should be eager to learn. If their interest is not captured at school they are unlikely to be interested later. Many of the difficulties in the way environmental education apply especially to adult readers.

OBSTACLES TO ENVIRONMENTAL EDUCATION

1. The Reader's Too Ready Acceptance of the Printed Word

One difficulty in communicating information and ideas about the environment is that the author may be accepted not only as an expert but also as an authority. Every sentence in a school textbook, for example, is likely to be accepted by most readers as true: information to be absorbed without question. We might expect science books to be accurate but they do contain mistakes. Also scientists are part of the climate of opinion in which they were themselves educated. Opposition to new ideas comes not just from politicians with political beliefs suited to earlier times, or religious leaders whose religions are rooted in the past, but also from scientists whose knowledge is

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built upon their teachers' knowledge. Inevitably, teachers of science and science writers perpetuate their own misconceptions and misunderstandings (Barrass, 1984). It is only when students read several books on a subject - and most do not do this until after leaving school - that they begin to recognise different interpretations of evidence and differences of opinion based more on the author's preconceived ideas than on the evidence presented.

2. The Reader's Preconceived Ideas: Time Needed to change the Mind

Paper, first produced in China, was manufactured in Europe from the twelfth century - but it was the invention of the printing press in Germany in the fifteenth century that made possible the communication of ideas and information accurately to a wide readership. It is no coincidence that the scientific method of enquiry, relying on evidence instead of authority, was widely accepted soon after the start of printing.

Eratosthenes of Alexandria (276 to 194 BC) calculated the circumference of Earth but his work was ignored, forgotten or lost (Jackson, 1985) and for another 1700 years people continued to believe that the world was flat. However, people could still feel secure in the belief that the world had been created at the centre of the universe. Proof that the sun was at the centre of our solar system, presented in 1543 by Copernicus in his book On The Revolutions of the Celestial Spheres and in 1632 by Galileo Galilei in The Chief World Systems - Ptolemic and Copernican was not accepted because it conflicted with current belief which was supported by the authority of Ptolemy (dating from the second century AD) and by religious dogma. Also, everyone could observe the movement of the sun across the heavens each day.

People who have already accepted something as true are reluctant to change their minds. This applies today and it applies to scientists as well as to others. We all have our beliefs and our judgements are affected by them. This has always been so and always will be so. Perhaps on the whole people do not change their minds. This is a difficulty faced by anyone who has something new to say. Rather, it is each new generation that grows up in a climate of opinion as to what is or is not acceptable to society. Four hundred and fifty years after the publication of the book by Copernicus, we have no difficulty in accepting his view of the world and the universe.

Darwin's The Origin of Species by Means of Natural Selection, published in 1859 a year after his joint paper with Wallace in the Journal of the Linnaean Society of London, challenged widely accepted beliefs not of the place of the world in the universe but of the place of people in the world. Here is a book that should have influenced our thoughts not only about the environment but also about ourselves in relation to other living things. Yet, more than a hundred years after the publication of Darwin's book, conservation is still made difficult by the fact that many people are reluctant to accept that we are part of nature, not above nature. Even for the sake of the future of mankind, it is necessary to conserve an environment in which there are other living things as well as people. We need a new ethic which, instead of putting people first, always puts the environment first.

In writing books for environmental education it is necessary to consider the possibility that some things that are currently accepted as true are no more than dogma. Authors of books for environmental education may have to challenge accepted opinions, firmly held beliefs, and even what have been called basic human rights - such as the right to work and the right to have enough food for a healthy life, irrespective of the number of people; and the right method of parents to decide when and how many children they should have, irrespective of the resources available for them. If all the people in any place are to have agreed rights, must they not also accept that they have responsibilities such as the responsibility to relate their numbers to their resources and ultimately to relate world population to world resources?

The purpose of all education, not just environmental education, should be to teach people to think. Here is another difficulty for writers of books for environmental education - and for their readers. People seem incapable of standing back and considering the consequences of their own actions as clearly as they would if similar changes were being affected by any other species. For example, any other species multiplying as people have done in the last two hundred years and having such damaging effects on the environment would be considered a pest.

3. The Reader's Slowness to Act on Information Provided

Even when people are aware of a problem and have accepted the need for action, no action may be taken until it is too late to prevent disaster. In North America a dust bowl was created before there was a wide appreciation of what was happening. The book Vanishing Lands or The Rape of the Earth (Jacks and Whyte, 1939) had a tremendous impact worldwide, but people in other parts of the world have been slow to accept that they had a problem and that urgent action was needed. In Australia, for example, soil erosion became a prominent political issue in the 1930s but it was not until 1951 that the enactment of soil conservation legislation was completed in all mainland states; and the costs of soil erosion continue (Australian Government, 1978). A major problem is that soil erosion is worst in areas where farming is least worthwhile - and where the cost of effective control measures would be greatest. Soil erosion is a world problem and its effects are not confined to the tropics. In England, for example, land is being made less productive - encouraged by financial aid schemes which encourage farmers to remove hedgerows and to grow cereals in monoculture, even on land that is unsuitable for cereal cultivation.

Similarly, people have been slow to accept the consequences of mechanisation and automation on employment, unemployment and leisure. In 1948 legislation was introduced in the British Parliament for family allowances for all except the first child in any family - not just for children of the poor. At the time it was believed that large numbers of people would be needed to work in an expanding industrial society. Less than twenty years later, in *The Age of Automation*, Bagrit (1965) wrote: 'Within twenty-five years, automation will have made the old concept of charity obsolete. We may eventually reach the stage where the work to be done will need perhaps only a third of the population to provide fully for everyone and leave plenty in hand ...' If the right to work is a basic human right, is continuing high unemployment, and rising unemployment, an indication that the world is over populated, or is it that work and leisure should be shared more evenly instead of some working full-time and others being unemployed?

On issues such as these it is easy to understand why governments in a democracy are slow to act on the information available to them. There are few votes for trying to lead people where most of them do not as yet want to go. Environmental education for all must precede political action.

World population problems will not be solved by increasing food production. The history of mankind is one of increasing food availability, by one means or another, allowing population growth. At the end of *Biology: Food and People* (Barrass, 1964), I summarised some conflicting opinions about the effect of people on the environment. People may be called optimists or pessimists but it is not necessary to predict what may happen. Observe the present: deforestation, overgrazing, desert expansion, widespread famine and increasing unemployment. The rate of change in the environment is now so rapid that many individuals can see in their own lifetime what people are doing to the world. Yet governments are slow to act in relation to world problems because they cannot agree about what, if anything, should be done.

4. Language Used by the Writer

Another difficulty in environmental education is that the specialists who know most about aspects of the environment may not be best qualified to communicate their thoughts to non-specialists.

Robinson (1970) in *Effective Study* makes unfavourable comparisons between the quality of writing in textbooks and that in literary essays, and states that the really effective writer of essays chooses words carefully, composes sentences and paragraphs so as to convey meaning clearly and precisely, and arranges ideas in sequence to sweep the reader along. Robinson considers that writers of textbooks do not do these things.

Books for students can be recognised by their tables of statistics, graphs, complex diagrams, the citing of sources, and the listing of references. But it should not be necessary for them to be hard reading. On the contrary, scientific writing should have all these characteristics: explanation, clarity, completeness, impartiality, order, accuracy, objectivity and simplicity (Barrass, 1978).

If academics have difficulty in producing effective compositions, this is probably because they spend very little of their time writing. Giving lectures based on concise notes, with minor modifications from year to year, does not provide the practice in writing that makes for easy communication. Talking to a captive audience, like writing for a learned journal, is not necessarily an effective way to learn how to capture and maintain the interest of readers who could be spending their time on other things.

The author of a novel must capture and hold the reader's attention. Otherwise no publisher would be interested in the work: the book would be read by nobody else. Academics have the advantage that their student want to know.

So who is to write books for environmental education? Books for specialists must be written by specialists, but who is to interest and inform the wider audience: who is to influence the decision makers? Academics may feel best qualified to write specialist books and may also consider that career advancement is best assured by writing research papers for learned journals and academic books that will impress their peers. Those who recognise that they do not write well are also likely to feel that they should leave what might be called adult education to people who can match their writing to the needs of the reader.

Most scientists rely on science journalists to draw their discoveries to the attention of a wider audience. Journalists know that to capture and hold the interest of people every story must be about people or about things as they relate to people - and preferably as they relate to the reader. This is why local news is usually more interesting than national or world news to the general public. So, in relation to environmental education, it is best if what is happening is near to or in the home. Research scientists and academics can make their work more accessible to science journalists by writing short articles for such publications as *New Scientist* and *Scientific American*. We should value the work of journalists who write well.

The books that will capture the interest and imagination of educated adults are also the books needed by students of environmental science to help them to see their course in a wider perspective. Another kind of book that should have a major part to play in environmental education is the novel. Consider the impact of the novels of Charles Dickens and other nineteenth century writers, making people think about the environmental conditions in which other people lived.

In the twentieth century some authors of fiction have referred to the environment and the rate of change. E.M. Foster in Howards End (1910) wrote of London:

> 'To speak against London is no longer fashionable. The Earth as an artistic cult has had its day, and the literature of the near future will probably ignore the country and seek inspiration from the town. One can understand the reaction. Of Pan and the elemental forces, the public has heard a little too much - they seem Victorian, while London is Georgian - and those who are for the earth with sincerity may wait long ere the pendulum swings back to her again.'

R.C. Sherriff in A Fortnight in September (1931) wrote about a seaside family holiday. He described the journey from London by train:

> 'The country was flatter now: to the casual eye not so fine as the country they had passed, and yet to the Stevens every yard of it was pregnant with memories. They passed a white house ... which had scarcely got its roof on when they passed last year, and a garden laid out with strippling trees. They saw with sorrow a place where last year a dense wood had been ...
>
> "I suppose one day, said Dick, "there'll be houses all the way from Clapham Junction to Bognor".
>
> "Never!" sad Mr. Stevens - "they'll do something about it before it gets as bad as that".
>
> Ernie asked what they'd do, and Mr. Stevens winking at the others, said they'd stop any more little boys like Ernie from coming into the world and crowding out the grown ups, and Mrs. Stevens, joining in the laughter, found herself laughing easily and happily ...

and in A Reed Shaken by the Wind, a travel book, Gavin Maxwell (1957) wrote about changes in population distribution and changing attitudes:

> Of the eight million people who live within the frontiers of Iraq, Baghdad now holds over a million, and more pour into the city every day. Except in the remote tribal areas the children now receive a school education, and as a result consider themselves too good to work on the land; indeed work on the land is considered to be the lowest of all occupations.

Today the science fiction writer is concerned, for example, with space exploration and space travel, and with the after-effects of an atomic war, not with overpopulation in an underdeveloped country - or in a developed country. Has any novelist since John Steinbeck (The Grapes of Wrath, 1939) written about soil erosion and its impact on the lives of people in impoverished lands? Has any novelist written about the loss of farm land due to deforestation or urbanisation, about the drift into towns of people with no land and no money, about unemployment in towns increased by this drift, or about the effects of depopulation on the depleted rural areas? The scientist has failed to bring the problems of today forcefully to the attention of the people of today - but perhaps the novelist could succeed.

Those interested in environmental education must inform not only (a) specialists and students of environmental science but also (b) the population as a whole, and especially (c) those who make decisions about the environment. People will accept from literature things that they are not yet ready to accept from scientists and politicians. Books can cause the call for action to come from the people, so that in a democracy politicians can follow the wishes of the people instead of trying to lead people where they are not ready to go.

In these days of mass media the book still has a part to play. The reader,unlike the listener or viewer, can move slowly or quickly, can weigh words and distinguish evidence from opinion, can re-read to confirm a correct understanding, and can read again at any time. Television and radio may serve to stimulate interest but books are needed by those who want to know more.

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DEVELOPING ENVIRONMENTAL EDUCATION IN TEACHER EDUCATION

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INTRODUCTION

Environmental sciences include the natural and technological sciences that advance the use of natural resources, and also involve economics, legal science, sociology, philosophy, psychology and education. Environmental education is also concerned with values and emotions.

General aims for environmental education have developed (UNESCO 1980). One primary aim is to enable people to understand the complexity of the environment, resulting from the interaction of biological, physical, social, economic and cultural aspects.

Learning about the environment goes on throughout life so a major characteristic of environmental education is that it is for people of all ages - and is concerned with problems faced by individuals and by society. To solve environmental problems insights into several disciplines are required, so environmental education must be problem-centered and inter-disciplinary. Also, because actions taken now may affect the environment for years to come, environmental education must be forward-looking.

Value judgements are important in choosing solutions to problems. Consequently in the environmental sciences it is necessary to consider how education affects the formation of values; and how the study of the environment affects an individual's intellectual growth.

Discussions about the relationship between man and the environment is natural in environmental education. It has also aroused interest among philosophers, recently, and the term ecophilosophy has been adopted (Skolimowski 1983).

Whether people make decisions as individuals or in groups, ultimately these decisions are determined by what are considered important and by how the short and long-term consequences of decisions on the environment are examined. People have to make such decisions throughout life. Therefore, it is reasonable to suggest that environmental education should be for everyone - in the various phases of life, at each stage of education and afterwards.

RESEARCH BASED INFORMATION IN DEVELOPING ENVIRONMENTAL EDUCATION

One of the starting points of the environmental education project in the Teacher Education Department, Joensuu University is clarification of the relationship between people and the environment. The kinds of decisions people make in solving environmental problems, and what determines the decision, have been investigated. First, the nature of environmental education was discussed to form a basis for designing a theoretical framework for the empirical part of project - the results of which are used in this paper. The viewpoints of cognitive socio-emotional and ethical education have been considered previously (Aho 1984a, 1984b).

In planning environmental education it is necessary to know the solutions and the factors affecting different issues. This information can then be used in teaching, to help students clarify their views and values in relation to current environmental problems.

People are wholly dependent on the environment. Due to scientific research, the effects of man's actions are largely known. However, no agreement prevails in society on how and to what extent nature should be exploited. The use of nature changes the biophysical environment. Total nature conservation is not feasible. It may well be difficult to decide to what extent people are entitled to use the environment for their own purposes, the decision will depend on what factors are considered.

In planning education it is necessary to know the possibilities available in the use of nature, so that short- and long-term effects can be estimated. There may also be differences in the extent to which technical facilities are available to avoid detrimental effects. Educational objectives should include a comprehensive examination of environmental problems and a consideration of solutions that provide a compromise between man and nature.

In order to develop environmental education in teacher education, students' (intending teachers) orientations to environmental problems and solutions were studied. An environmental problem was outlined and then the students were asked what would most probably have been their solution (Table 1).

The exercises dealt with building a nuclear power station, turning a park into a business quarter, establishing a nature conservation area, building a hazardous waste disposal plan, establishing a tourist centre in the wilds, building an industrial plant, and building a hydroelectric power station. These were considered, in the above order, by students in different teacher education departments.

Their choices varied in terms of the kinds of use of the environment but there were practically no differences in response between the degree programmes.

Turning a park into a business quarter and building a nuclear power station seemed to be opposed most strongly, whereas establishing a nature conservation area, building a hazardous waste disposal plant and building an industrial plant were regarded as positive ways of using mature. These opinions reflect prevailing priorities and values in Finnish Society.

TABLE 1a Class Teacher Education Students' Attitudes Towards Using The Environment (%)

	1	2	3	4	5	6	
Nature Conservation Area	35	38	24	2	1	1	n=161
Hazardous Waste Disposal Plant	12	19	33	17	11	10	n=157
Industrial Plant	10	22	40	16	9	3	n=156
Tourist Centre	6	20	39	21	9	4	n=159
Hydroelectric Power Station	2	1	6	35	28	30	n=156
Nuclea Power Station	1	3	13	25	23	35	n=156
Park Business Quarter	3	1	2	13	24	59	n=160

1 strongly agree, to 6 strongly disagree

TABLE 1b Subject Teacher Education Students' Attitudes Towards Using The Environment (%)

	1	2	3	4	5	6	
Nature Conservation Area	31	29	39	2	3	0	n=313
Hazardous Waste Disposal Plant	13	18	29	24	9	8	n=312
Industrial Centre	7	20	47	19	5	2	n=308
Tourist Centre	4	18	41	28	8	2	n=310
Hydroelectric Power Station	0	2	11	30	23	34	n=311
Nuclear Power Station	1	3	13	22	24	38	n=311
Park Business Quarter	0	1	2	13	21	63	n=313

1 strongly agree, to 6 strongly disagree

Further, because cross-disciplinary approach is one characteristic of environmental education, the students' viewpoints were examined, and also the points they thought would be taken into account in making decisions on the use of nature. Ecological, socio-economic, social, ethical and aesthetic points of view were taken into consideration (Table 2).

TABLE 2 Points of view Used by Subject and Class Teacher Education Students in Considering Environmental Problems (%)

	1	2	3	4	5	6	
Subject Teacher in Education	188	256	114	65	29	84	n = 281
	67	91	41	23	10	30	max = 100%
Class Teacher in Education	96	133	87	35	25	50	n = 148
	65	90	59	24	17	34	max = 100%

1 ecological; 2 socio-economic; 3 social; 4 ethic; 5 aesthetic, and 6 general.

Contamination and destruction of the environment (i.e. ecological effects in nature) were regarded as disadvantages in the use of nature. Even more students discussed the socio-economical effects of decisions - especially employment problems. Many students considered the social effects of various decisions. The preservation and protection of life were classified as ethical aspects, and so there were also statements referring to the value of living organisms. Clearly, fewer students pointed to aesthetic values, and this is in line with earlier findings in studies of school children (Aho 1984c).

In analysing students' answers, it was necessary to consider:

1. how environmental education could be developed so that the various disciplines and values involved could be presented in a balanced way; and

2. how the cross-disciplinary and problem-centred characteristics of environmental education should be taken into account.

Students themselves feel they have an incomplete conception of the mutual relationships between man, nature and society. And depending on their degree programme, they feel better able to master compartmentalised information about nature, man and society. This could suggest that teacher education has not been able to provide an interdisciplinary approach, where a given problem would have been analysed from the viewpoint of several disciplines and then integrated into a justification for a decision.

The students in both of the degree programmes (i.e. intending class and subject teachers) also hold the traditional view that environmental education mainly belongs to the teaching of environmental studies (81% of the students). The aims of environmental education are variously realised, according to the students, in the teaching of (geography (75%), biology (74%), mathematics (63%) and foreign languages (52%). In the degree programme for subject teachers there were students who had not previously heard of environmental education. It seems probable that all the subject teacher's degree programmes do not deal with environmental education even though it could well be incorporated - for example into subject didactic studies.

WAYS OF IMPLEMENTING ENVIRONMENTAL EDUCATION IN TEACHER EDUCATION

When class teacher education was reformed in Finland in 1979 general studies were introduced into the curriculum to support the student's personal development and, at the same time, to provide views, information and skills. The aims of one course in general studies on Man, Nature and Society, included the provision of information about the interrelationships of these objectives. A successful planning and implementation of the course would require co-operation of teacher educators, which, however, may have failed in teacher education departments because students do not feel that they can acquire a total conception of the relationships. In subject teacher education general studies support the degree programme of a given discipline, and consequently are nto part of the same degree as in class teacher education - oriented towards broad, general education.

One problem in environmental education is the educators, who in general have a narrow degree, in one or two subjects, whereas environmental education requires and outlook that is able to combine several points of view. Therefore, achieving interdisciplinary environmental education calls for the collaboration of educators.

Students become familiar with the aims of school education while they are at college. In developing the degree programmes for subject teachers, environmental education should be included in the subject didactic educational studies, in the same way as some other comprehensive school subjects that are taught across the curriculum (e.g. education for international understanding). Teacher eductors need to be trained and informed in order that the student should not go through a degree programme without hearing the views of different specialists. General studies lectures on Man in the Ecological Framework, are one current project at Joensuu University. In this year's lectures, experts from different disciplines presented their views on the relationship between people and the environment. The last lecture was by a representation of education, who offered a synthesis and drew conclusions for teacher education. The other lectures were on ecology, regional science, physics, history, national economics, legal science, anthroplogy, aesthetics and philosophy. The general aim of the lectures was to develop interdisciplinary general studies within the theme man, nature and society. The lectures also produced teaching material for those training as teachers.

Research into the relationship between people and the environment produces background information for implementing environmental education at various levels of education. Further, research focusing on teaching about the environment in schools contributes to the existing information about organising instructions. It is not easy to do research in environmental education, at least in a pluralistic society. One problem is the choice of the values to be taught. As yet, discussion about values in education has not been very animated.

However, discussion about values, and related educational research, seems to have become more popular in recent years. In research it is necessary to consider theoretical starting-points. Practical experience alone will not provide an adequate basis for curricula.

As students in class teacher education have to write their Master's theses in education, it has been possible to offer research projects in the Teacher Education Department of Joensuu University dealing with the relationship between people and the environment, from the viewpoint of education. Students have started investigating for example environmental problems and how to consider them in class, having first surveyed how pupils respond to different environmental problems and solutions to them. Further, according to the aims of the curriculum, pupils are to be taught to make reliable observations about the environment. However, there is a need to investigate what features attract pupils' attention and what they actually perceive. This would provide a basis for designing class exercises or field work in which pupils could be guided to observe and analyse events in the environment. These events would also include experiences and feelings, an aspect that could also be taken into account in education oriented towards the environment.

Education is not value-free; instruction covers things that are regarded as important. Perhaps environmental education is not appreciated enough; more money and time could be spent on it. Those interested in instruction and research in environmental education should give more consideration to what environmental education is. In my opinion, it is a central component in our view of the world - on our relationship with the environment - with nature above all. The future of life on Earth may depend on the man-nature relationship. This adds urgency to environmental education.

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THE GLOBAL ENVIRONMENTAL EDUCATION PROJECT 1984-86

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INTRODUCTION

Each year the earth has less tillable soil, more deserts, smaller forests, fewer plant and animal species and more pollution. The biosphere is deteriorating because of our increasing numbers and needs (Brown, 1985; UNEP, 1984; UNESCO, 1980; World Wild Life Fund, 1983). The world is already overcrowded and by the year 2000 there is expected to be another 1300 million people. Because almost 90% of the growth is occurring in Asia, Africa and Latin America, four-fifths of people will live in Third World countries where most people are already poor. About 800 millions live in conditions the World Bank (1981) has described as "Absolute poverty ... a condition of life so degraded by disease, illiteracy, malnutrition and squalor as to deny its victims the basic human necessities." Such widespread poverty has resulted in the devastation of large areas of once-fertile lands on three continents. Many cities, including Bombay, Cairo and Mexico City, overflow with poor people who have no other place to go. Faced with such huge problems and driven by the need for income, most Third World governments have encouraged local and foreign investors to exploit their natural resources - forests, for example - with scant regard to environmental consequences.

Only about 25% of the world's people live in the developed rich nations of Europe, North America, Japan, Australia, and the OPEC countries. Yet they consume 80% of the world's resources. The developed nations also suffer the ills of environmental abuse. In all countries fertile soil is being covered by urban sprawl, washed into streams or carried away by winds. In the United States, a third of the croplands are eroding at a rate which, if continued, will drastically reduce future grain production. In many developed countries, forests are being logged faster than trees are growing. Wetlands are being diked and drained to make way for houses and hotels. And pollutants, the side products of industrialisation and high consumption, continue to degrade the air and poison groundwater supplies, lakes, rivers and coastal waters. The earth, if it is to provide the means by which all people can survive and prosper, can no longer tolerate the destruction of ecosystems by either poor or rich nations. It is the task of this generation to act to reverse the damaging trends that are making the planet less and less fit to live in.

In this context the World Wildlife Fund has supported a wide ranging programme of environmental education to foster in students of all ages a greater sensitivity to and an awareness of, important global environmental issues and concerns. One of its recent initiatives is the Global Environmental Education Project, described in this paper, which is an attempt to incorporate matters of environmental concern

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in a teaching programme for class use. Specific teaching and learning materials are being developed to introduce particular issues across the curriculum, in an attempt to provide relevant information and advice on teaching methods.

The focus of the learning programmes being developed is children and the world environment they inhabit; as occupiers of space, as consumers of resources, as global participants and as decision takers for the future. The project attempts to reflect these features in the resources produced and in the approaches to learning and teaching employed within an interdisciplinary framework and mainly for the age range 8-14.

Global environmental and development issues and concerns will be explored and the approach will be innovative, imaginative and radical, allowing active participation of teachers and pupils. A programme for both pre-service and in-service teacher education will accompany the teaching units, with methods closely allied to the knowledge, skills, concepts and values of the different learning programmes.

Understanding the interaction of systems and the interdependence of man-environment relationships is regarded as a fundamental concern of any programme of education which attempts to give children some means for engagement with the future that they are likely to inherit. The responsibility of the present generation of educators is to ensure that the decisions the next generation takes are much less destructive of their environment than ours have been.

Five institutions of education have been cooperating to produce learning programmes. Practically all the pilot programs are complete and are being improved in the light of trials.

1 Children as Occupiers of Space : Birmingham Development Education Centre
Materials for pupils and teachers are being developed for use in existing environmental studies courses:- (a) the local world; (b) exploring attitudes; (c) world environmental system; and (d) the environment in debate.

2 Children as Intervenors and Actors in the World Environment: Centre for International Studies, Rolle Collge, Exmouth
The programme has five elements for a ten week teaching module:- (a) teacher guidelines; (b) awareness; (c) consolidation; (d) analysis; and (e) action. Resources and materials will include slide packs, worksheets, decision sheets, self-evaluation sheets, simulation games and role play and, a teachers' handbook.

3 Children as Consumers : Bedford College of Higher Education
This learning programme for pupils aged 12-14 will provide a form of social studies education, with a strong emphasis on political and multicultural education, of the kind taught in Britain for ten years as World Studies.

4 **Children as Decision Takers for the Future : Jordanhill College of Education, Glasgow**

The approach in this programme is interdisciplinary, drawing upon the sciences, literature, art and craft studies, history, geography, economics and modern studies.

The purpose of this learning programme is to help children understand that what we are doing to our environment will have far reaching consequences.

5 Teacher Education Programme : World Studies Teacher Training Centre, York University

An introductory handbook is being produced for teachers to help them choose units for use in their classrooms. There is also a teacher training module (as follows) for pre-service and in-service courses, on environmental education, which will be useful for any teachers who want to know more about the teaching materials.

TEACHER TRAINING MODULE : DRAFT OUTLINE

SECTION 1 : GLOBAL PERSPECTIVES IN ENVIRONMENTAL EDUCATION

i) Why global perspectives are necessary

- planet as a global system
- interdependence of world issues, problems and threats
- solutions to be found through holistic analysis and treatment
- role of the individual in the global system

ii) Differing perspectives on the global environment

- planet in peril? Some perceptions, causes and solutions
- the environment and political systems
- the environment and belief systems.

iii) What are attainable global perspectives?

Development and adaptation of Hanvey's 'Attainable Global Perspective' in its five dimensions, i.e. -

- perspective consciousness
- 'state of the planet' awareness
- cross-cultural awareness
- knowledge of global dynamics
- awareness of human choices.

SECTION 2 : GLOBAL PERSPECTIVES IN THE CLASSROOM

i) Creating the 'global classroom'

- rationale for process-oriented learning
- classroom climate and organisation
- developing and refining skills, including media awareness skills
- examples of experiential and participatory approaches to global environmental education.

ii) The child, the classroom and the world

- teaching and learning about controversial issues
- involvement of parents and community
- relationship between education and action.

iii) Environmental education across the curriculum

- global environmental perspectives in maths, chemistry, home economics, etc.
- insights of curriculum areas to an issue-based approach.

SECTION 3 : RUNNING A COURSE/WORKSHOP

i) Importance of planning : detail and flexibility.

ii) Course design: 'rhythm'; appropriate use of resources; harmony in medium and message.

iii) Evaluation : 'on the spot' reactions; short- and long-term evaluation techniques.

iv) Some sample workshop programmes.

SECTION 4 : SOME EXPERIMENTAL AND INTERACTIVE TECHNIQUES AND APPROACHES

This section to describe and evaluate further examples of techniques and approaches which might be used in teacher education, with suggestions for classroom adaptation where appropriate. (Note : some examples will be given at relevant points throughout the module).

SECTION 5 : RESOURCES

- suggested background reading
- other suitable classroom materials
- organisations.

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ACCESS TO COURSES IN ENVIRONMENTAL SCIENCES/STUDIES IN HIGHER EDUCATION FROM U.K. COLLEGES OF FURTHER EDUCATION

: A CASE STUDY

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INTRODUCTION

Most students in the UK enter Higher Education after attending courses at a school or College of Further Education and then passing appropriate subjects in advanced examinations taken at 18+. Colleges of Further Education provide alternatives to the traditional post-16 school curriculum. Their emphasis in course design and provision has to be on flexibility because the market demands of the community are changing. In particular the pool of 16-19 year olds qualified to enter post-school education is declining largely as a result of falling birth rates. In addition there is increased competition for students and resources. Youth Opportunities (YOP) and subsequent Youth Training Scheme (YTS) programmes for 16-19 year olds are providing attractive alternatives to school and Higher Education courses, for the decreasing numbers of potential students (Kedney, 1985). As a result, resources are likely to be moved from the education of 16-19 year olds, as the numbers in Further Education decrease (see also Audit Commission, 1983).

As the traditional client group declines, an obvious development is to seek other sources of students for academic courses so that present levels of provision can be maintained. With high unemployment, mature students, already about 45 per cent of full-time equivalent entrants in public sector (non-university) Higher Education (NAB, 1984), are such a source. Some courses in Further Education colleges already provide alternatives to traditional 'A' level courses for entrance to Higher Education.

THE PRE-HIGHER EDUCATION ACCESS COURSE AT CHILDWALL HALL COLLEGE OF FURTHER EDUCATION

This course, established in 1983, which is validated and moderated by Liverpool Polytechnic, is designed for adults who left school without the qualifications usually required for entrance to higher education. Co-operation with the Polytechnic ensures academic rigour and appropriate objectives for the course.

COURSE COMPONENTS

Each student attends six major units, five of which are assessed. The initial structure was:

(a) Foundation Skills Units
(1) Study Skills; (2) Communication/English; (3) Numeracy/Mathematics; (4) Computer Appreciation.

(b) Special Subject Units
Two from: (5) Historical Studies; (6) Politics and Economics; (7) Social Sciences; (8) Twentieth-century Literature.

After an initial year, units (9) Environment; and (10) Business Studies, were added in 1984 to increase choice and decrease the Arts bias. Students either take a foundation course before proceeding to special subject units or, if attending full-time, the whole course may be completed in one year. Credit is given for units passed, but the course does not normally exceed four years. Because full-time students can complete the course quickly, compared with 'O' and 'A' levels, this course is attractive financially to adults who wish to proceed as quickly as possible to higher education.

CHARACTERISTICS AND APPROACHES OF THE COURSE

Emphasis is placed on learning to analyse and communicate, not just on acquiring knowledge. It is in these skills that many mature students are weak and feel insecure.

Admission is open: there are no entrance requirements. However, students are counselled and guided. Students are encouraged to begin with the foundation units in Study Skills, Communication/English and Numeracy/Mathematics. These have diagnostic value for students wishing to progress to special subject units.

Students are assessed by written and oral course work (50 per cent final assessment) and by written examinations (50 per cent of final assessment). Satisfactory completion of the course means that the student has achieved a pass mark of 50 per cent in all written and oral assignments and in the examinations in the special subjects.

Students applying for admission to an institution of Higher Education can present both their final assessment as a College Certificate, and all their assessed coursework, and the College provides a confidential report. Further detailed information of the course is available from the College (Liverpool Education Authority, 1985). Major features of the Environment Unit are now presented as a case study.

ENVIRONMENT UNIT

Use of the title "Environment", rather than Geography, permits the inclusion of both the Earth and Social Sciences and so provides students with a basis for courses in Higher Education - and fosters an holistic view of the planet. Also, students take much pleasure in studying aspects of Science, often for the first time, in a context so relevant to their lives.

The design of the unit involved research into first-year degree programmes in both Environmental Science/Studies and in Geography. The most appropriate mode discovered for the purposes of this course was the first year degree programme in Environmental Science at

Plymouth Polytechnic, because of its holistic approach was most useful for our purpose. Many environmental texts and courses still exclude people and culture concentrating on the Earth Sciences - which would be inappropriate for students proceeding to degree courses in Geography. The strength of the environment approach is that it is interdisciplinary.

Table 1 Course structure: two hours per week for each system plus one hour tutorial/seminar per week

Week	Earth Systems	Ecosystems	Human Systems
1-6	Earth	Ecosystems - introduction and concepts systems theory	Human Evolution and Early Population
7-12	Lithosphere - origins of rocks plate tectonics geological cycle	Plants and vegetation	Early Agriculture and Pre-industrial Populations
13-18	Hydrosphere Water; States of Matter Hydrological cycle	Soils development, fertility management ----------------- Animals (herbivores and carnivores)	Commercial Agriculture Technology Urbanization
19-25	Atmosphere Energy transfers, weather & climate	Types of Ecosystem and Contemporary Problems (Woodland, Lakes, Moorlands coasts, Deserts)	Industrialization Population/ Resource Problems
26-32		Watershed Ecosystems (UNIFYING THEME)	

Table 1 shows the teaching programme: the environment is studied as three basic types of system: physical, biological and cultural (O'Sullivan, 1980) modified as Earth Systems, Ecosystems and Human Systems. The division of the environment in this way is false, as they are interrelated, but is of great advantage in teaching. Links are emphasised in the horizontal banding of topics in Table 1; and as an over-riding theme in teaching all aspects. The vertical structure of the table progresses as far as is practicable in complexity and time. The final theme also attempts to unify the tripartite division. The value of watershed ecosystems in performing such a function is well documented by O'Sullivan (1979, 1980).

The first three areas, Earth, Ecosystems and Human Evolution, and Early Populations, are on a macro-sale, in simplified form, whereas subsequent areas examine the micro-elements.

Topics common to the concepts-based Joint Matriculation Board Advanced Level Geography Syllabus B (JMB, 1984), already offered by the College, and to the Plymouth Polytechnic 'Concepts' first year syllabus, where chosen first. About two-thirds of the topics included are in this category.

Other essential topics, from the environment perspective, include the formation of the solar system, physical and chemical properties of water, the 10 per cent law, nutrient cycles, plants in ecosystems, photosynthesis and respiration, animals, human evolution, early populations and early agriculture, and pre-industrial populations.

Topics from Geography include basic geomorphology, the von Thunen model of rural land use; Urban function models of Burgess, Hoyt and Ullman; Christaller's hierarchical model of settlements; and Weber's industrial location model.

Although both disciplines may feel that some essential areas have been omitted, it must be remembered that the existing methods of accepting mature students, i.e. by mature matriculation examinations, provides students who are usually unaware of recent developments in any subject. The advantages of accepting a student after successful completion of such an Access course therefore far outweigh any shortcomings of course content. Because teaching methods must encompass the methodology of both disciplines, spatial, temporal and scientific lines of enquiry are pursued. In addition to more traditional teaching and lecturing methods, the understanding and evaluation of contemporary problems involves decision making and simulation exercises and enquiry-based learning. Students are taught relevant supplementary statistics in their Mathematics/Numeracy foundation unit. They also use appropriate computer software and are introduced to fieldwork.

COURSE EVALUATION

Lees (1985) has dealt with course evaluation in detail. The Environment Unit has been offered for only one year so that course interpretation can only be provisional. In terms of take-up and popularity the Unit was one of the two largest options. The shortage of time meant the range of work including field visits completed was reduced. However, satisfactory levels of analytic skills and personal confidence were achieved. So far, 39 students from this course have been accepted for courses in 13 Higher Education institutions in the United Kingdom.

Students on this course have required more reassurance and support than 'A' level students. Also, students feel insecure without an overall course textbook but this results from the holistic and interdisciplinary course structure and is considered good training for independent study in higher education.

Courses such as the one described here are only one facet of new means of accreditation being devised by many Further Education colleges with Higher Education Institutions. Initiatives are being taken in many parts of Britain to introduce Open Learning opportunities, to enhance access to both academic and vocational college courses, for post 16 age groups. Such innovations require increased flexibility in modes of attendance, course structures, timing of courses, facilities for students, teaching and learning methods. The National Advisory Body Report (NAB, 1984), identified many barriers to access for potential students and made recommendations for their elimination.

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SOURCE, PERFORMANCE AND DESTINATIONS OF ENVIRONMENTAL STUDIES STUDENTS AT AVERY HILL COLLEGE

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INTRODUCTION

The Avery Hill Diploma in Higher Education (DipHE) in Environmental Studies, approved by the Council for Academic Awards in 1978, enrolled its first students in 1979. A holistic approach to environmental issues is provided by first year studies of Earth Science, Life Science, Social Science and Quantitative Techniques, and by second year studies of Energy Resources, Human Ecology, Perspectives on Resource Development and Quantitative Methods (McPhee, 1980). As well as revising these courses additional courses (Environmental Chemistry and Man and Environment) were developed prior to revalidation in 1982 (Figure 1).

The course has attracted many mature entrants, with non-standard entry qualifications (McPhee, 1983). This paper is mainly about the experiences of these students, as well as those of standard entrants, have been accommodated.

COURSE EVALUATION

Initial difficulties were due to partly overloading students with theoretical and empirical material and partly to incomplete integration of material from different subjects. The diverse backgrounds of incoming students also caused difficulties in some courses in attempting to achieve an adequate grounding in all subject areas in the first year. These problems were initially met by providing additional remedial tutorials, specific directed reading and regular diagnostic tests to identify students' difficulties. Problems of content were resolved by changes in some courses in the second year of running followed by more fundamental revisions in the revalidated programme.

Initially, particular difficulties were encountered in two first year courses:

1. In Social Science (which covered Economics, Human Geography, Politics and Sociology) students who generally had no Social Sciences background experienced problems although they found the course interesting. Thus,revision of the course involved reducing the content.

2. In Quantitative Techniques the main difficulty was in bringing students with little experience of quantitative analysis to a reasonable level of ability in one year.

```
Year 1

                 ++++++++++++++++               ++++++++++++++++
                 +  Quantitative +              + Environmental +
                 +      and      +              +  Chemistry #  +
                 + Experimental  +              ++++++++++++++++
                 +   Techniques  +
                 ++++++++++++++++
   ===========                   ===========                  ===========
   = Social  =                   = Life    =                  = Earth   =
   = Science =                   = Science =                  = Science =
   ===========                   ===========                  ===========

                          ###############
                          # #  Man and  #
                          # Environment #
                          ###############

Year 2

  ==========   +++++++++++++++                  ================
  =  Human  =  + Quantitative +                 = Perspectives =
  = Ecology =  +  Techniques  +                 = on  Resource =
  ==========   +++++++++++++++                  = Development  =
                                                ================
                             =============
                             =  Energy   =
                             = Resources =
                             =============

===  Main course          +++ Service course           ### Integrating course
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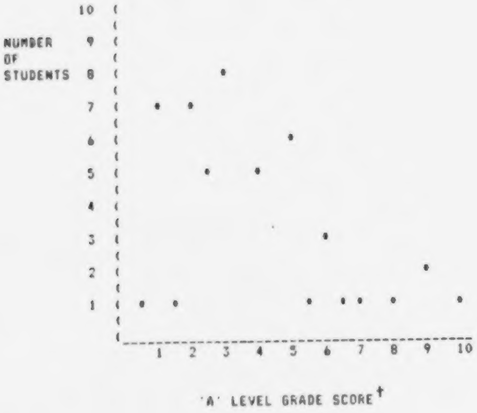
FIGURE 1 Structure of Dip.H.E. Environmental Studies Programme

> Initial difficulties in content and timing in relation to other courses, were resolved by using more environmentally relevant material and liaising more closely with other courses to provide just the necessary/appropriate quantitative skills.

The new first-year courses were Environmental Chemistry and Man and Environment. The former introduced basic principles of Chemistry, as a foundation for work in Earth Science and Life Science and the latter reinforece inter-disciplinarity by considering basic aspects of human/physical environment relationships, and formed a 'bridging' course between first and second years. They were added partly as a response to the nature of the student intake and partly as a result of experience in teaching.

SOURCE OF THE STUDENT INTAKE

The course has attracted a high proportion of mature entrants; many without standard entry qualifications (Table 1). Data are presented on students' occupational background prior to enrolling (Table 2), 'A' level subjects (a) taken and (b) passed, before entry (Table 3), and grade scores at 'A' level (Figure 2).



+ A score of 0.5 has been given for an 'O'level pass at 'A'level

FIGURE 2 'A' Level Grade Distribution - Incoming Students

TABLE 1 Annual Recruitment to the Dip.H.E. 1979-1985

YEAR	TOTAL INTAKE	MEAN (and S.D.) AGE	MATURE ENTRANTS	NON-STANDARD ENTRANTS	
				NUMBER	AS % OF TOTAL
1979	12	29.16± 8.88	10	8	67%
1980	15	21.73± 3.86	9	4	27%
1981	27	25.77± 5.99	23	18	67%
1982	30	25.51± 5.74	24	18	60%
1983	26	30.15± 11.10	19	13	50%
1984	36	28.08± 8.47	28	21	58%
1985	28	23.89± 7.67	22	16	57%

TABLE 2 Occupational Backgrounds of Dip.H.E. Students

Clerical/Secretarial:	25	Sales/Trade:	6
Gardening/Forestry/Agriculture:	19	Armed Forces:	5
Laboratory/Scientific:	17	Self-Employed:	4
Engeering:	15	'Housewife':	2
Manual (e.g. Labouring)	14	Outdoor Instruction:	2
Nursing:	10	Library:	1
Managerial/Supervisory:	8	School Leavers:	35
Teaching/Community Work:	7		

Note: Where an individual had several jobs, the most recent one or the one for which the person seemed best qualified was chosen in preparing this table.

TABLE 3 'A' Level Subject Backgrounds of Incoming Students 79/85

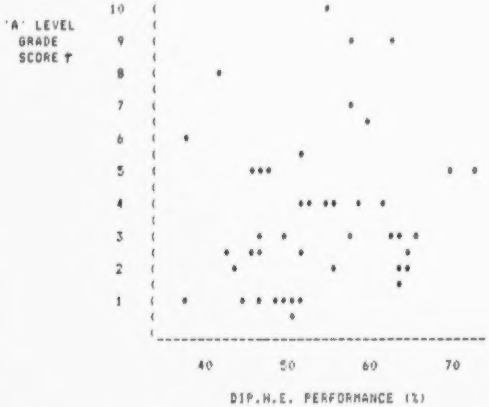
The first figure shows the number of students taking a subject at 'A' level and the figure in parentheses the number passing in this subject.

Geography:	33 (31)	Botany	2 (2)each
Biology:	25 (24)	Business Studies	
Chemistry:	15 (9)	Environmental Studies	
English:	13 (11)	French	
Physics:	12 (7)	Government	
Economics:	11 (8)	Statistics	
History:	10 (9)	Communication Studies	1 (1)each
Mathematics:	6 (3)	Design and Technology	
General Studies:	5 (4)	Geology	
Art:	5 (4)	Music	
Sociology:	3 (3)	Social Biology	
Zoology:	3 (3)	Technical Drawing	

ASPIRATIONS AND PERFORMANCE OF STUDENTS ON THE DIP.H.E.

Most students entering the course are seeking a broad-based programme of environmental study (McPhee, 1981; King, 1983) which provides a base for further studies. General interest in the environment has been a stronger source of motivation than concern to follow a specialised course of study or to enter a particular career. The strong environmental concern expressed by many mature entrants may be related to their backgrounds (Table 2) springing from direct experience of the natural environment (gardening/forestry/agriculture/outdoor instruction : 17%) or from experience in one of the caring professions (nursing/teaching/community work : 14%). Another motivating factor is the wish to obtain further qualifications to improve career prospects (clerical/secretarial/manual : 26%). Finally, some entrants with technical or trade qualifications were unemployed and saw no immediate prospect of re-employment in their chosen field. (Laboratory/scientific/manager/supervisor/sales/trade : 34%). They thus viewed the course as a means of career reorientation.

Students performance on the Dip.H.E. (based on Year 2 assessment, involving examinations and coursework, represented in percentage scores) has been related both to 'A' level grades and to subsequent third-year degree performance, where applicable. No clear relationship was found between 'A' level grades and Year 2 performance (Figure 3). Although data are few, these finding support the conclusions of McPhee (1983), Wood (1983) and Mills (1983). Indeed Streddar (1983) noted that mature students performed better than standard entrants which may be due to the greater motivation of most mature entrants. The performance of students in Year 2 of the Avery Hill course leads us to a similar conclusion.



+ A score of 0.5 has been given for an 'O' level pass at 'A' level.

FIGURE 3 'A' Level Grades and Dip.H.E. Performance

Also there appears to be no measurable difference in performance between those students who would normally have been accepted by Polytechnics (minimum of two 'A' levels at grade D = 4 points) and those who would not (Table 4). Furthermore, even the best-qualified of the Avery Hill intake, in terms of 'A' levels were in the middle of the possible range of 'A' level grades, yet they performed well in Year 2 here and in Year 3 following transfer (see below).

TABLE 4 'A' Level Grades (In Relation to Formal Entrance Requirements) and Dip.H.E. Performance

Dip.H.E. Performance (In Degree Class Equivalents)	'A' Level Grade Scores Above Entry Requirements	Below Entry Requirements
1st	2	0
2.1	3	7
2.2	9	8
3rd	4	8
Fail	1	1

DESTINATIONS OF DIPLOMATES

Most students plan to transfer to the final year in a degree course in one of the linked Polytechnics. Initially these were Plymouth, City of London and Wolverhampton.[4] Although the link with Wolverhampton has lapsed due to changes in course content, four more have been added: North East London, Hatfield, Sunderland and Manchester. Also a number of students have attempted, independently, to negotiate for transfer to degree courses at Newcastle, South Bank and Central London Polytechnics, King's and Queen Mary Colleges of the University of Londona and the University of Kent, but transfer to the final year has not been possible due to an incomplete match between Dip.H.E. and degree course programmes. The numbers transferring into the final year of degree courses (Table 5), the pattern of student enrolment for the final year (Table 6) and the relationship between Year 2 and Year 3 performance in two receiving institutions (Table 7) are given. Most students going on to Plymouth Polytechnic saw relatively broad connections between second and third year content and those going to Central London Polytechnic saw more specific content links. In the appreciation of the Dip.H.E. as a base for degree work, however, it was not possible to distinguish between students whose performance improved between Year 2 and Year 3 and those whose performance deteriorated.

POST-DEGREE DESTINATIONS OF STUDENTS

Information on employment of former students is incomplete. After graduation eleven have obtained employment not directly related to their studies, eight are either teaching or considering starting teacher training courses, and nine are working for higher degrees.

TABLE 5 Numbers Trasnferring Into Degree Courses

1979 entry : 9 (out of 9 completing the Dip.H.E.)
1980 entry : 13 (out of 14 completing the Dip.H.E.)
1981 entry : 16 (out of 20 completing the Dip.H.E.)
1982 entry : 22 (out of 23 completing the Dip.H.E.)
1983 entry : 12 (out of 13 completing the Dip.H.E.)

TABLE 6 Destinations of Diplomates for Third Year Courses

	PLY	CLP	PCL	NELP	THA	HAT	PSB	MAN	SUND	OTH
1981	7	1	1	-	-	-	-	-	-	-
1982	7	6	-	-	-	-	-	-	-	-
1983	9	4	-	2	-	-	-	-	-	1
1984	6	11	-	-	-	-	-	2	2	1
1985	4	4	-	-	1	1	1	1	-	-

Key: PLY = Plymouth Polytechnic
CLP = City of London Polytechnic
PCL = Polytechnic of Central London
NELP = North-East London Polytechnic
THA = Thames Polytechnic
HAT = Hatfield Polytechnic
MAN = Manchester Polytechnic
SUND = Sunderland Polytechnic
OTH = Other (Queen Mary College London and Napier College Edinburgh)

TABLE 7 Dip.H.E. and Degree Performance

YEAR 2	YEAR 3	CLP	PLYMOUTH
2.1	1st	1	1
2.1	2.1	-	8
2.1	2.2	1	4
2.2	2.1	1	2
2.2	2.2	5	7
2.2	3rd	-	1
2.2	Pass	-	3
3rd	2.2	4	1
3rd	3rd	-	2
3rd	Pass	2	-

The total picture of performance in Year 3 may thus be summarised as follows:

1st : 4; 2.1 : 12; 2.2 : 23; 3rd : 3; Pass : 5.

Four students did not complete their third year courses and two (one from the 1979 intake and one from the 1981 intake) are currently engaged in third year courses.

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CAREERS AND CAREER EDUCATION FOR ENVIRONMENTAL GRADUATES

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INTRODUCTION

The U.K. Government White Paper The Development of Higher Education into the 1990's stressed the importance of seeking value for money (HMSO, 1985). One criterion in assessing the value of degree courses is the employability of graduates. The Council for National Academic Awards (CNAA), who validate Polytechnic degree courses in the U.K. is currently analysing the employment history and performance of 2,700 graduates in the labour market (Boys, Brennan & McGeever, 1985). The Industrial, Commercial and Professional Liaison Group of the National Advisory Body recently has concluded that 'academic institutions should review the performance of its graduates in relation to the national picture for use in its own course reviews and planning.' On recent visits to Sunderland Polytechnic, Her Majesty's Inspectors (H.M.I.) have confirmed that such graduate destination data will be used in judging the success and viability of courses.

DESTINATIONS OF ENVIRONMENTAL GRADUATES

Each year national data on the first destination of graduates are collected by Careers Advisory Services in Higher Education (AGCAS, 1985; CRAC, 1985). These data, however, are not comprehensive: for example the 'unknown' rate for University graduates in 1984 was over 10% compared with 15% for Polytechnic graduates. Furthermore, because there are relatively few Environmental graduates, small shifts in employment patterns can distort the figures. Equally, the numbers proceeding to further study/training should also be considered in trying to understand the opportunities open to graduates. Although not too much emphasis should be placed on graduate destinations only six months after graduation, NAB has recommended that "first destination statistics should be used in making decisions at the national level on future provision in different subject areas."

Despite these reservations, it is necessary to analyse the data in order to respond to the probable external scrutiny of courses in the future. In Table 1, the first destination of University and Polytechnic Environmental graduates 1981-3 are compared with those of graduates in all subjects. The percentage of Environmental graduates entering permanent employment has been consistently below the all subject level. Unemployment rates for Environmental graduates have been consistently higher than the national average for all graduates. The employment prospects of University and Polytechnic Environmental graduates have been strikingly similar. The only major difference is in the higher percentage of Polytechnic graduates proceeding to further academic study in 1983 (14.1% compared to 7.3%) of University graduates. This contrasts with the pattern for 1981 and 1982 and is

Employment Grouping	1981				1982				1983			
	University Graduates		Polytechnic Graduates		University Graduates		Polytechnic Graduates		University Graduates		Polytechnic Graduates	
	ES	OTHER	ES	OTHER	ES	OTHER	ES	OTHER	ES	OTHER	ES	OTHER
Permanent Employment (UK)	37.2		33.8	45.7	37.2		39.0	47.7	43.5	49.9	41.3	52.6
Short-term Employment	3.9		10.9	5.6	3.9		9.9	5.7	5.8	2.9	7.0	5.2
Further Academic Study	14.7		10.9	7.5	15.1		10.3	7.0	7.3	10.8	14.1	5.9
Teacher Training	9.6		7.3	5.8	4.5		5.8	3.5	5.2	6.1	6.3	3.3
Other Training	4.1		1.5	7.0	6.4		1.7	7.4	5.5	10.1	4.0	7.5
Employment Overseas	3.0		10.9	3.1	2.8		4.1	2.4	3.0	2.2	2.6	1.9
Overseas Students leaving UK	2.4		2.5	9.2	2.2		0.8	9.1	0.7	5.1	0.7	6.9
Unavailable	4.8		1.1	1.5	3.6		2.5	1.4	4.0	2.0	2.6	1.8
Unemployed	20.3		21.1	14.7	24.3		25.9	15.7	22.8	10.8	21.4	14.8
Nos. of Total Known	334		275	16,347	358		243	16,383	329		383	17,473

Table 1

Destination of University and Polytechnic Graduates in Environmental Studies (ES) and all subjects (OTHER) 1981-1983

(AGCAS, CRAC 1985)

due to the sharp fall in the percentage of University graduates proceeding to further academic study. Consideration of Polytechnic graduate destinations in two Science subjects (Biology and Chemistry), in two Social Sciences (Sociology and Psychology) and in one arts subject (History) reveals that the employment rates of Environmental graduates are (1) comparable with the Science and Social Science degrees and (2) better than those of the History graduates.

These findings go a considrable way to contradict the view of many local authority career officers that students graduating from Environmental courses face particularly difficult employment problems. Additionally, if the type of work entered by Environmental graduates and the type of employers who recruit them is examined it is clear that these graduates do successfully enter a broad range of occupations. Thus, Environmental Science/Studies should be regarded as a non-vocational degree providing a broad-based education leading to a wide range of environmental and non-environmental careers.

LONGITUDINAL SURVEYS OF ENVIRONMENTAL GRADUATES

Since first destination data can give no indication of long-term career progress it is also necessary to consider longitudinal career data. A number of longitudinal career surveys have been conducted in recent years but only Moseley (1981) deals with Environmental graduates.

First destination data (based on six months after graduation) reveal little about basic career prospects because some graduates delay job hunting until after graduation and some may choose to remain unemployed until they obtain the 'right' job. Furthermore, in the transition period after graduation, individuals may experience phases of unemployment, part-time employment, voluntary work or further study/training.

To explore the performance of Sunderland's Environmental Studies graduats a survey initiated in 1984, used and extended an information base in 1981 which covered graduates since 1977. This longitudinal survey provides information on: (1) the labour market orientation of our graduates since 1977; (2) their career records; (3) an insight into tactics and strategies adopted in their search for work and career development; and (4) retrospective comments on how relevant and helpful their undergraduate studies had been to their careers.

The Sunderland BSc Environmental Studies degree is an integrated and holistic course. Students are accepted with any combination of 'Advanced' Level (an 18 plus examination in the U.K.) subjects if Mathematics Ordinary Level (16 plus examination) and formal science qualifications are included. Mature students without 'A' level are accepted and total 14% of graduates between 1977 and 1985. All students in the survey had followed the same course (now significantly modified) consisting of a broad curriculum in the first two years and a more specialist final year based on either a Planning the

Human Environment option (A) or a Management of the Physical Environmental option (B). Such specialisation could affect employability. The questionnaire was, therefore, designed to determine if option choice, as well as date of graduation, and gender affected career development.

As far as possible, all graduates (1977-84) were mailed and 84 replies (75%) were included in the analysis. The sample was broadly representative (67% male; 33% female, 33% Option A: 67% Option B) in entry qualifications (Tables 2A and 4), class of degree (Table 2B) and age (Table 3).

No statistical analysis is offered in this exploratory paper and further analysis is needed to validate the findings. However, the results are reported with considerable confidence and are being used in course planning and the development of a career education programme.

Three themes are pursued below in relation to the survey: (1) the effects of changes in the job market before and after 1981 which is suggested as the year when graduate opportunities deteriorated; (2) the career performance of male and female students; and (3) the performance of Option A and B students, controlling other intervening factors such as differences in entry qualifications and age. In the following discussion, results from a CNAA survey (Boys et al, 1985) are given where comparison is possible.

CAREERS OF SUNDERLAND POLYTECHNIC ENVIRONMENTAL GRADUATES

As in the CNAA survey, (1) graduates from this inter-faculty/interdisciplinary course entered a wide variety of careers, not all related to the environment, and (2) approximately half felt overqualified in their first job.

There was evidence that our graduates have found it easier to find employment since 1981. This may indicate employers' increased awareness and acceptance of Environmental Studies, or shifts in job opportunities or changes in student attitudes. Despite increasing unemployment in the U.K., since 1981 16% of Sunderland graduates have been employed immediately upon graduation (compared with 10% before 1981). This small proportion is similar to that for other courses and is not surprising given the tactics of many students in their employment search (see below).

Sixty-two per cent of those graduating after 1981 found permanent employment within a year compared to 53% of those graduating before 1981. Unfortunately at the time of the survey, 10% of those graduating before 1981 were still seeking their first permanent post. More men than women obtained permanent employment immediately upon graduation (17.9% : 3.6%) but more women than men obtained such employment within a year of graduate (67.9% : 53.6%) unemployment rates were the same overall, for both.

TABLE 2

Qualifications of graduates included in the survey

A ENTRY QUALIFICATIONS

Nos of A levels	%
4	6.0
3	16.7
2	63.1
1	6.0
0*	8.2

B CLASS OF DEGREE

Class	%
1	3.6
2.1	22.9
2.2	56.6
3	12.1
Degree	4.8

* Students with Scottish Higher, B/TEC, OND/C and mature entrants

TABLE 3

AGE OF THE GRADUATES INCLUDED IN THE SURVEY 1974-82 (n = 84)

AGE IN YEARS	AGE AT GRADUATION %	AGE AT TIME OF SURVEY %
21	53.6	-
22 - 23	32.1	32.1
24 - 25	10.7	25.0
26 - 30	-	38.1
31 - 35	3.6	1.2
36 - 40	-	2.4
41 - 45	-	1.2
46 +	-	-

TABLE 4

SUBJECT BACKGROUND: PERCENTAGE OF STUDENTS ENTERING WITH DIFFERENT 'A' LEVEL SUBJECTS

SUBJECT	%	SUBJECT	%
Geography	51.2	Economics	9.5
Biology	41.7	History	7.1
General Studies	20.2	Environmental Science	3.6
English	16.7	Sociology	3.6
Mathematics	13.1	Art	2.4
Chemistry	11.9	Modern Languages	2.4
Physics	11.9	Others	9.5

In relation to their final year specialisation, students taking Option B fared better than those taking Option A (14.8% : 10.3%) in obtaining permanent employment immediately, but not after one year.

TACTICS AND STRATEGIES USED IN THE SEARCH FOR EMPLOYMENT

Faced with a difficult labour market and increasing competition it is paradoxical that a large proportion of students do not start to look for work until after graduation (36% in the CNAA survey). Very few Sunderland students decided upon their careers before entry to the course although many had clear preferences. The time and effort required to search and apply for jobs may account for the delay in serious job search until after graduation.

The Sunderland Survey revealed a variety of tactics used by graduates in their search for employment:

(a) widening occupational choice - not restricting applications to 'environmental areas';

(b) increasing geographical flexibility - applying for jobs in any location;

(c) accepting lower remuneration to that at first expected;

(d) accepting jobs for which degrees are not essential and part-time and/or temporary work;

(e) undertaking voluntary work as a means of gaining experience for entry into paid employment;

(f) adopting a more aggressive approach to job-seeking.

ATTITUDES, PERCEPTIONS AND EXPECTATIONS OF GRADUATES

About a third of the sample gained their first choice occupation for their first employment : (31.3 of those graduating before 1981 and 32.8% of those after 1981).

40% of the sample did not consider their present job as their first choice and many claimed they were unable to secure their first choice because of competition, or the lack of experience or personal skills.

Level of satisfaction with jobs improved with subsequent jobs, which suggests graduates gradually jockeyed into better positions after initially experiencing problems of access and attainment. 9.9% were very dissatisfied with their first job, 7.0% with their second, 2.8% with their third and none with their fourth. Men had much higher job satisfaction levels than women and Option B students higher than Option A students. Like graduates from East Anglia (Moseley, 1981), Sunderland graduates secured more environmentally orientated and/or professionally acceptable jobs through this job-changing.

Clerical, manual, technical and part-time categories declined in importance in comparison with occupational areas such as management, administration and the welfare services. However, 1981 does not appear a significant watershed and upward mobility is a feature of the whole period of the survey. This trend does not appear to be affected by age, gender or class of degree.

Despite difficulties experienced, 60% of the students felt their undergraduate job expectations had been realistic. To compete better and attain better jobs over half (52.4%) undertake some form of post-graduate study or training although 17.9% of these did not believe this had helped them in their career to date. These figures are higher than comparable figures in the CNAA research but lower than Environmental graduates from East Anglia. There was no evidence that gender, specialisation in degree option or date of graduation influenced the uptake of post-graduate study/training.

Many former students felt that the factual and analytical skills content of their course had been neither relevant to nor helpful in their careers but they appreciated those aspects that contributed to the development of personal skills.

CONSEQUENCES AND IMPLICATIONS FOR ENVIRONMENTAL EDUCATION

Given that taught facts and subject related skills were not considered very relevant, especially after their first employment, and that personal qualities such as confidence, maturity and the ability to communicate were more important in the eyes of the respondents a number of questions may be asked about the nature and philosophy of environmental education.

Do the aims and processes of academic environmental education restrain or conflict with the identification and development of transferable skills needed in employment? A closer alignment of study skills with those skills required by employers makes sense. Employers demand good communication skills, numeracy and the ability to work as a team member. Essay and report writing, tutorial and seminar discussion and project preparation are probably at least as important, therefore, as lectures and practical work.

Should degree courses in Environmental Studies/Science not be more vocational and develop specific content and skills? The Sunderland course has always been, and still is, non-vocational. However, in 1984 more directly vocational units have been introduced to help develop report writing, seminar presentation and management skills.

THE CAREER EDUCATION PROGRAMME AT SUNDERLAND POLYTECHNIC

Short career programmes concentrating on Job Search techniques have been organised on a voluntary basis by the Careers Advisory Service since 1981. Since 1984, however, an Environmental Studies careers education programme has been progressively time-tabled as an

Table 5 CAREER EDUCATION PROGRAMME : PART OF ENVIRONMENTAL STUDIES DEGREE AT SUNDERLAND POLYTECHNIC

Year 1 Week 3

Introduction to the work of the Careers Advisory Service.

Week 15

Gaining work experience. Voluntary work. Guest speaker from Voluntary Conservation group.

Year 2 Week 3

Career opportunities for Environmental Studies graduates. Employment experiences of Sunderland Polytechnic graduates.

Week 15

Gaining work experience: career value of projects.

Week 23

One day careers conference.

Week 33

Planning for the final year.

Year 3 Week 3

Applying for employment: preparing application forms and c.v.'s

Week 6

Review of post-graduate courses, further training and job opportunities for Environmental Studies graduates. Analysis of student destinations. Source of information about opportunities.

Week 7

Employers' selection methods. Preparation for interviews.

Week 9

Short talks by Sunderland Polytechnic graduates on their experience in seeking work and in employment.

Week 11

Practical exercises on interview techniques.

obligatory part of the curriculum (Table 5). The involvement of all students could, therefore, be guaranteed. It also encouraged a clear working relationship between academic staff and officers of the Careers Advisory Service.

The career education programme concentrated on opportunity awareness and job search skills. The decision to emphasise these aspects was based upon previous experience in running similar courses and a conviction that self-awareness elements could best be introduced in individual counselling interviews which students were encouraged to use.

In 1984 the programme was directed primarily at final year students with an emphasis on the need for a professional approach to seeking employment. Feedback from employers repeatedly stresses that most students are poorly prepared to perform effectively in a competitive market. Any improvement in students' skills should, therefore, help in their search for employment.

Given that Environmental Studies students find employment in a wide range of occupations, improvement in job search skills should be complemented by an increased awareness of the available opportunities The occupational awareness element of the programme was designed to explore the options open to our students, to outline possible strategies to help them secure their career goals and to emphasise that many environmental graduates enter employment in non-environmental fields.

In careers counselling individual Environmental Studies students regularly demonstrate little understanding of the competitive nature of the job market. Group activities and discussions in the career programme can help them to approach the problem in new ways and provide further opportunities to emphasise the marketability of the degree for a variety of graduate careers.

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THE RELATIONSHIP BETWEEN ENVIRONMENTAL STUDIES/SCIENCES AND ENVIRONMENTAL EDUCATION : SOME PERSONAL EXPERIENCES

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I graduated in Environmental Studies from Sunderland Polytechnic in 1984 and am currently employed by Newcastle Architecture Workshop Limited in developing environmental education. In this paper I discuss the relationship between Environmental Studies/Science and Environmental Education and how my studies have contributed to my work.

The course at Sunderland Polytechnic provides an advanced education in the understanding, planning and management of the environment, and is underpinned by physical and social sciences. Topics covered include conservation, land use and pollution as well as contemporary environmental issues and policies. My first year course included studies of biology, chemistry, geography, economics and politics. Basic techniques and methods of using environmental information (including mathematics, statistics and computing) were introduced so that local environments could be examined and contrasted with other environments in the UK and elsewhere. In the second year I learnt to appreciate the intimate relationships between the physical and social environments. This was highlighted in a residential fieldweek in which the impact of the North Sea Oil Industry on Aberdeen and its surrounding areas was considered. The final year continued the study of environmental issues. However, there was a sense of progression in that the emphasis was placed on solution rather than on identification and analysis. Clearly, this prescriptive approach fitted in well with the recognition that learning about the environment must encourage a felt concern for it (Ball, 1973). It should then be possible to move away from such concern to taking action to improve and enhance the environment. The Sunderland course also provides the chance to specialise (see Blair and Dugdale) and to undertake a major project. My project 'Environmental Education: the Role of the City Farm' allowed me to consider theories of environmental education; and my present employment has given me the opportunity to see them in practice.

Environmental education means different things to different people and objectives depend on the values and interests of those advocating the need to teach about the environment. One of the most quoted definitions (IUCN, 1970) is that environmental education is the process of recognising values and clarifying concepts in order to develop skills and attitudes necessary to understand and appreciate the inter-relationships among man, his culture and his biophysical surroundings.

UNESCO (1977) consider that environmental education should:

1. Foster clear awareness of, and concern about, economic, social, political and ecological interdependence in urban and rural areas;

2. Provide every person with opportunities to acquire the knowledge, values, attitudes, commitment and skill needed to protect and improve the environment; and

3. Create new patterns of behaviour of individuals, groups and society as a whole towards the environment.

The Newcastle Architecture Workshop, a voluntary organisation registered as a charity, was set up under the auspices of the Royal Institute of British Architects in 1977 by a small group of environmental education enthusiasts. It provides a community architectural aid and advice service, a complementary Voluntary Initiatives in Vacant Areas (VIVA) service, and an educational action, resource and research centre. These operate to implement the environmental and educational aims of the organistion - to help people of all ages not only to become more aware of and understand their surroundings, and developing critical responses to changes, but also to enable them to initiate and carry out proposals themselves. In education about the environment consideration must be given to the total environment: to the interaction of buildigs, spaces and people. We look not only at the past and present but, especially to the future, and the role which everyone could have in determining the shape of future environments. Implicit in this, we must acknowledge social, political and economic as well as physical considerations.

The education team seeks to develop and test new approaches and methods in long term school projects, in which children collaborate with the adults responsible for shaping their environment. Most of the work is in the built environment near the schools and the children's neighbourhood. It is not necessarily based on one subject but provides a vehicle for developing literacy, numeracy and creativity, for collecting and classifying information, for asking questions and making value judgements, and for experimentation, speculation and problem solving.

Our work also gives pupils the opportunity to negotiate with their teachers what it is they want and need to learn, promotes links with the community, encourages the participation of the pupils in the community, and enables pupils to take action in the environment using an issue based approach. We also try to develop political literacy.

After the initial request from a class teacher we discussed the general ideas for the project. At this stage aims and objectives are clarified and agreed. The detailed planning of the work is very important. Having committed our services we:

1. suggest a flexible scheme of work with tested activities which may be new to the teacher;

2. identify areas in which our technical staff can best be used or the resources of local authority or private architects and planners;

3. work in the classroom alongside the teacher;

4. organise and supervise field work;

5. produce materials and resources for use in and outside the classroom; and

6. at the end of the project produce a detailed report (NAW, 1983).

The Environmental Education movement has been growing and now involves many bodies and organisations. Thus, it is open to main interpretations. The term Environmental Studies is used more than Environmental Education. Environmental Education is a process - an approach to teaching - rather than a subject with a body of knowledge to be transferred. In other words Environmental Studies is academic whereas Environmental Education is education in its broadest sense - a catalyst for knowledge, attitudes and values to be explored across the curriculum.

My course in Environmental Studies broadened my education rather than increasing my knowledge in a particular subject but one wonders if it is possible to be a professional environmentalist anyway.

My job title is Community Liaison Officer but I also work in schools. This fits the belief that the foundations of environmental awareness should be laid down while people are young. I am not a qualified teacher but have contributed to environmental education projects. Thus, knowledge and skills gained at college have been used, including basic library research skills.

In environmental appraisal exercises it was necessary to simplify techniques so that they were presented in a form suitable for young children and, in working with an architect, I was learning as well as the children. Knowledge of local planning gained at Sunderland was valuable, especially a role-play exercise in which we readily grasped the difficulties involved in this work. In my work it was interesting to note that the children experience similar problems - such as personality clashes in their working groups. The architecture content of my course at Sunderland was minimal, and although I learnt about public participation, the course did not include working with community groups. These are clearly major criticisms, which need to be rectified as the community planning/architecture movement continues to grow and more gradutes become involved.

My Environmental Studies course was relevant to my present employment and I feel sure some of my fellow graduates will agree that their careers are vocationally linked to the course. Others have used the general training - which used a scientific approach - to evaluate information from a wide variety of sources before communicating these evalutions. Others have progressed to post-graduate research and further study.

Despite the success of many graduates in finding relevant employment, the course emphasises the study of the physical, biological and cultural aspects of the environment. In this way, like all courses, it can be considered to be exam-orientated, with learning carried out on an individual basis. Students have no experience of team work and difficulties arise when the graduate works with others and must accept a responsiblity to them.

Much time in Environmental Studies courses is spent in the lecture room, but a true understanding of the environment can come only through experience. A major objective should be to bring to life abstract elements of the curriculum. Thus, more time should be spent in the field, involving teaching, research and community involvement. At the same time there is a need to play down the lecturer to student teaching role; lecturers need to realise that they also are in learning situations. Some graduates have difficulty in applying knowledge gained at college to the outside world. Links with outside agencies would lessen the belief that the lecturer is an authority on all environmental matters.

Another desirable change would be to replace the exam-orientation of the course by continuous assessment, to move emphasis away from training for continued life within the education system. Closely linked to this is the proposal to play down the emphasis on individual work and promoted team work in its place. Only then will graduates of such courses be prepared for employment, understanding the total environment and its associated problems and awareness on how to become involved in helping to solve these problems, and motivated to work towards their solution. (Strapp, 1974).

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VOCATIONAL PERSPECTIVES OF AN ENVIRONMENTAL TRAINING

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Over the last fifteen years, as pressure on the environment and public awareness of the environment have increased, many courses in Environmental Studies/Sciences have been established in the United Kingdom. At the same time employment prospects have improved and the numbers of vacancies in environmental management have increased. But do the courses prepare students for employment?

Experience in seeking employment and in my first post since graduating from the Environmental Studies coruse at Sunderland Polytechnic in 1983, has taught me that in some ways they do not and that my knowledge of my chosen career is still incomplete. This is probably the experience of most graduates and is partly of their own making - as benefits and rewards depend greatly upon individual effort. Also

1. it would be unreasonable to expect any course to teach all there is to know about a subject, and

2. there is a conflict of ideas between academics and employers resulting from the incompatibility of academic and work environments. Each side, entrenched in its own ideas and philosophy, is not fully aware of the other's needs and functions.

By its very nature a first degree course has to be academic in approach and content, but should not consideration be given to allowing opportunities for the development of skills needed by the employer? Fieldwork, visits, projects and seminars all help but their value is limited.

Knowledge and experience of work, no matter how limited, is what many employers seek. Unfortunately, to incorporate this into the Sunderland degree in Environmental studies would not be easy, as the course by its very nature was broad-based and therefore unspecialised. The variety of options in which to acquire working skills and practices of immediate value to the employer is extensive, rendering such experience more diffiuclt to arrange than in a specialised course. This is a well known problem in Environmetnal Studies but there are a number of possible solutions.

Perhaps the easiest solution to introduce and promote is for the student to gain experience by voluntary part-time vacation work. This is particularly suitable in a practically based outdoor profession such as biological conservation and countryside management. A number of organisations could provide such employment but both commitment from the student and encouragement from the lecturers and course organisers are required. To this end I suggest closer co-operation between educationalists and employers.

Perhaps visiting employers could be encouraged to give talks and to meet students to facilitate such co-operation. This would also have the beneficial effect of allowing employers to meet and assess a student. The employer may be impressed by the fact that a student wants to do voluntary work. Certainly my employer considers this very important and almost as valuable as the degree obtained; and this is how I secured my present position.

During my interview I was pressed very hard to prove my practical ability and initiative, and I believe my involvement in the creation of a graduate employment society, and in voluntary work in Conservation, helped me considerably. Obviously formal qualifications played a major role in my appointment, even though my employer had only a limited knowledge of the content and objectives of a degree in Environmetnal Studies.

Closer co-operation, therefore could benefit both students and employers, giving greater perception and insight into the nature of environmental education and employment. Course structure and organisation, if geared towards a more specialist knowledge of fewer subjects in the degree would also relate the course more closely to the needs of particular employers. This might not give the student working and practical skills but most employers seek a specialist knowledge. Certainly in my work I have so far used only about half of the knowledge gained in my degree. This raises a question of philosophy. What is the purpose of Higher Education? Should it be geared solely towards employment or should the acquisition of knowledge be an end in itself. Most would agree that both are needed and other things such as character building and development of personality and the ability to think.

Environmental training must be geared towards employment, but I am happy to possess a wider knowledge, even though it is not all put to use in my present position. It may be used in a future role, but regardless of this there is more to a degree than vocational training.

In relation to the validity of an Environmental Studies/Sciences degree the following questions, which may seem radical, are based on experience and working knowledge: Does teaching of Environmental Education have to be contained or confined to a single and general purpose degree? Can it be broken into parts? Would single courses in Conservation or Earth Science or Environmental Chemistry be of more value or relevance in the job market? Also, need the course result in a degree? Higher national Diploma (or equivalent) would be suitable if the course were to be shorter due to its narrower confines. Would employers recognise such courses and qualifications?

In relation to course structure, there is scope for sandwich courses in Environmental Studies/Sciences. A four year degree, including one year of work experience, seems desirable. This might require the student to specialise and therefore be committed to a particular career at an earlier stage than otherwise. Surely though this could be accommodated in degree structure and content. A sandwich course would be of substantial benefit in securing employment after graduation, particularly if the job placement had matched the employer's needs.

At work I come into contact with people who are making a living from the environment (including farmers and gamekeepers) or enjoying the countryside. What these people perceive to be an Environmental Studies/Sciences degree bears little relation to reality. Some understand, but in general Higher Education is out of touch with the people. To remedy this, links should be forged and co-operation encouraged. In spite of reservations expressed here, however, my degree course in Environmental Studies has been of great benefit to me and stood me in good stead for the future.

THE TEACHING OF VALUES AND LEADERSHIP IN ENVIRONMENTAL PROGRAMS

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INTRODUCTION

Because interest in environmental leadership programs is relatively recent, there is little agreement about the definition of leadership. This article provides a brief description of environmental leadership program models for those grappling with leadership questions for the first time.

CONVENTIONAL APPROACHES TO THE TEACHING OF LEADERSHIP

The teaching of values and skills important for environmental leadership usually corresponds to one or more approaches (Carter, 1983). The teaching of values can generally be described:

1. In the Classical approach, ideas, values and skills are presented objectively, primarily by a historical survey of important scholars. Most classroom exercises stress content rather than application. Theoretical rigor and historical depth are emphasised.

2. The experiential approach specifies that leaders should be trained in specific active arts and skills that develop the desired moral character for leadership. Accordingly, academic knowledge should relate both to students and to the world and help students to analyse social issues, reach informed ethical positions, and act in a socially responsible way. This approach stems from Plato's Republic and the American pragmatist tradition, particularly Dewey.

3. In the growth oriented approach values and leadership questions are examined in the context of a student's own immediate world - dealing, for example, with his or her attitudes about social issues. The approach stems from the works of Jung, Rogers, and Simon (Simon and Clark, 1975).

4. Developmental. This approach from Piaget (1965), assumes that leadership behaviour is predicated upon theoretical abstraction and information.

5. Preprofessional. Students are acquainted with values and leadership issues within a particular professional field or major. Aims are to expose students to issues which they are likely to experience as professionals, and to provide a transition from the academic to the professional world.

6. The inculcative approach, while perhaps examining a variety of values and leadership qualities, assumes a specific set of

values and leadership qualities to be presented to a student as the appropriate one.

The teaching of specific leadership skills generally corresponds to one or more of the following:

1. The rational/empirical model stresses cognitive and technical knowledge, and assumes that leaders can effect change by a process that explains the desired change, the reasons for such change, and provision of sufficient evidence to prove that change is desirable for all. The model assumes that leaders have knowledge, and the flow of knowledge is from them to those who do not have knowledge.

2. The normative re-educative model assumes that professionals become leaders by altering attitudes and values, and increasing knowledge.

3. The power coercive model predicates leadership qualities on political, economic and moral power. It includes knowledge and use of political and economic sanctions imposed on target groups to bring about change, effective use of mass media, and the coercive power of courts. The model is based upon the premise that behaviour usually precedes any firm values on a particular subject, and that the consequences of behaviour will determine whether a specific behaviour will continue.

4. The professional technical model assumes that individuals with specialized professional and technical expertise assist clients in development and implementation of their leadership skills.

5. The counter culture model is used by those who wish to develop leaders to assist or persuade individuals and groups to remove themselves from existing society and attempt to form co-operative groups with individuals sharing similar beliefs, attitudes, and values.

The conventional approaches to teaching values and skills necessary for leadership accommodate differing viewpoints and hence diverse constituencies of students and teachers. Important aspects of the approaches are that they facilitate the development of analytical and cognitive abilities, verbal and quantitative skills, familiarity with Western thought, knowledge of academic disciplines, and technical problem-solving skills. Further, the approaches sometimes use case studies, field trips, laboratory experiences, simulation games, and internships as methods for using the world beyond the classroom as a way of reinforcing classroom subject content. A major deficiency of all approaches is that they make inadequate provision for students to test ideals and values against personal experience.

Two examples of expanded leadership programs are provided. They are said to be expanded because a relatively larger part of the curriculum than usual is devoted to leadership skills and an increased effort is made to incorporate personal experience.

THE SIERRA PROJECT AT THE UNIVERSITY OF CALIFORNIA AT IRVINE - (UCI)

In this program students apply the skills they learn to problems in the community, while at the same time learning more about themselves and about the problems and perspectives of people they work with or assist: (1) All students in the program live in the same dormitory, where living and learning experiences are integrated. (2) The program centres upon a 4 unit lower division course (Social Ecology: Moral Development and Just Communities) which is offered each quarter. (3) Students may elect a 2 unit laboratory course in two of the quarters. (4) The program requires students to devote a minimum of 5 hours per week in learning/leadership community service projects.

The curriculum is organized around specific topics: (1) Survival Skills - How to organize time, how to study effectively, and how to prepare for and take examinations. (2) Social Perspective Taking - The development of empathy, defined as the ability to understand the point of view of another, and the ability to communicate that understanding, which involves basic listening and communication skills. (3) Community Building - Working together to create an atmosphere of openness, trust, and group support in an environment characterised by conflict resolution through decision-making. This module is not entirely self-contained, and is intertwined in classes in other modules. (4) Conflict Resolution in Society - Participation in SIMSOC, a commercially available simulation game in which students are given a vaguely structured role and allowed to form their own society. In the implementation of SIMSOC in the student dormitory, emphasis is placed on survival issues, personal goals, problems of power and authority, and what type of society provides the most good for the most people. Principles of fairness and justice are involved throughout the game, as are conflict resolution skills. (5) Life and Career Planning - Giving students the challenge of explicitly planning their lives, and learning how to apply what one knows or can learn about oneself in formulating education and long-term career plans. (6) Socialization - What arepeople like now? How did they come to be that way? What are salient factors and pressures in the socialization process? This includes race roles as factors in socialization and involves an examination of values and life styles. (7) Assertion Training - How to identify the personal rights involved in a conflict situation, and how to resolve that situation assuring one's own legitimate rights without violating those of others. (8) Community Service - Providing the opportunity for students to work with people with problems in a naturalistic setting and to apply skills learnt in the learning/living dormitory in a social-action community setting. This allows students to have positive contact with, for example, agencies outside the university community while still receiving support from the campus.

ALVERNO COLLEGE

The guiding assumption of the entire curriculum of the college is that "valuing" is thought to be essential to leadership and to a liberal education. The emphasis is on qualities of a student's thinking and acting, and less on quantity of knowledge. How the student values is an explicit and central focus of the curriculum. The programme is designed to assist students to develop their ability to discern and analyze values, to think through informed value decisions and to carry them into action. Approximately 75 per cent of the program consists of course work; the remaining 25 per cent consists of off-campus community or internship work.

The program focuses on eight general areas or competencies of valuing, which are fostered in most courses and include six levels.

GENERAL

Level 1
The focus is primarily on awareness of conceptual foundations, self-reflection, and certain aspects of what is involved in making value and leadership judgements and decisions.

Level 2
The student develops the ability to infer valuing and trace its sources. This accomplished by focusing on literary, artistic, historical, philosophical and religious works.

Level 3
The student further develops the ability to infer and analyze valuing implications, with an emphasis on scientific and technological systems. Project of how technological development will interact with varying cultures and their valuing frameworks are also made.

Level 4
Valuing is applied in complex decision-making situations. Learning experiences involve individual and group decision-making, and concern both personal and public issues.

ADVANCED

Level 5
The student applies valuing in intercultural settings. This involves extended community work experience.

Level 6
The student focuses on valuing in a holistic manner. A synthesis is made of valuing decisions, and goals and actions in regard to a critical issue in one's field of study. The issue may arise out an off-campus experience.

Although programmes of the Sierra Project of UCI and Alverno College (or some modification of them) may offer benefits because they are expanded compared with programs of one or a few courses, they nevertheless share, to a degree, a serious limitation. They lack responsibility and democracy.

Case studies, field trips, simulation games, and internships are worthwhile education tools, but they do not provide true involvement in the community and participation in controversial issues. Values and skills necessary for environmental leadership need to be tested against experience, or they cannot be said to have been fully developed. The reason is that problems are pervasive in life, and theory is always modified by experience. Further, none of the approaches discussed above introduces students to the community in any experiential sense. The typical college or university community consists of conflicting interest groups and of inherent inequality among students, faculty and administration. The ideas of and personal experience with mutual restraint, obligation, participation and agreement on major goals and basic philosophy that mark the discourse of true communities appear, at most colleges, only in textbooks. Education sufficient to develop leadership skills requires not only technical and organization skills, but involvement with authority structures in the Greek sense, where politics meant constant public participation in the ongoing effort to arrive at a good and just civic life. Research indicates that such involvement is perceived by most students to be significantly more influential than classroom content in shaping their moral reasoning and leadership qualities for community use (Whiteley, 1980).

However, such involvement emphasizes student autonomy and egalitarianism and consequently raises a troublesome issue. Conventional education structures favour teachers as the possessors and conveyors of knowledge, and the exercise of power and control therefore, resides in them. Whenever interpretations of the learner and goals of instruction encourage learners to select for themselves their own goals and to operate under egalitarian situations, a reevaluation of the traditional learning process must occur. Who commands the authority to define goals and strategies - students or teachers? Increased student autonomy and participation in community implies the equalization of teacher and student; this represents major academic organizational change. Are educators willing to encourage students to take a more active role in their education and their lives? How can educators encourage students to take an active role in their lives, participate in their communities, and provide them with real opportunities to grapple with leadership issues?

There is an additional, but related, problem arises from a conventional curriculum. Two curricula exist at colleges, the formal and the "hidden". The hidden curriculum consists partly of the way in which schools are organized and governed. The governance structure of many schools teaches students that they have little significant control over their lives in school, that they must conform to seemingly arbitrary rules or be punished, and that they should go along with the majority thinking even when they disagree. The hidden curriculum has a profound influence on the moral and civic education of students.

What students learn from the hidden curriculum often contradicts what they learn from the formal curriculum. Students are thus given mixed and conflicting messages. For example, students may be taught the virtues of democracy, but a college is less than democratic from the students' point of view. Students are often taught that they have individual rights and that they may take an action if they accept the consequences, yet seldom are the effects of one's actions on others clearly understood, or even seen for that matter. Meaningful civic education demands that the governance structure of the school and the formal curriculum of the classroom become congruent. An important assumption is that students will development leadership skills only if granted responsibility.

One education model which attempts to overcome these problems, but still remain within the framework of traditional education, is that of the Cluster School of Cambridge High and Latin School (Wasserman, 1980).

EXPANDED GOVERNANCE IN A LEADERSHIP PROGRAM

A cluster school functions as a semi-autonomous part of a larger, traditional school. An example of a cluster school is Cambridge High and Latin School. Cluster school students take courses specific to their school, but also take advantage of the wider range of curricular and extracurricular activities available in the larger school. The Cluster School's structure and procedures are derived from Kohlberg's research and from the collective experience of the community as its members strive to build and maintain the school. The major effort of the school is to stimulate leadership qualities through: (1) exposure to cognitive moral conflict; (2) role taking; (3) consideration of fairness and morality; (4) exposure to the next higher stage of moral reasoning; (5) active participation in group decision-making. The following are basic to the school's goals and operations: (1) The community meeting is the central institution of government. It promotes the controlled conflict and open exchange of opinions about fairness that are essential to the moral and leadership development of the individuals in the community. (2) The school opened with no rules or procedures, but with an agreement to abide by the rules of the larger school. The assumption was that students would quickly understand that if they did not make their own rules and develop their own procedures for handling them, they would be no better off than students in the traditional high school. (3) As issues arose, rules and the consequences for breaking rules were established, as are decision-making procedures in community meetings. (4) Advisor faculty serve as a support where students can discuss personal or academic problems. It differs from the small group in its focus on personal concerns rather than on community issues. (5) Staff and interested students meet periodically to review preceding community meetings, analyze the current functioning of the program, suggest new ways to meet problems which have arisen, develop the skills of staff members and students, plan upcoming community meetings, and clarify the staff's understanding about civic and leadership issues which come before the community.

Although the "school-within-a-school" concept provides for increased student governance, other educational models exist which provide even greater emphasis on egalitarianism and experience necessary for development of environmental leadership qualities. One notable example is Deep Springs College in California.

A STUDENT GOVERNED ACADEMIC/LIVING COMMUNITY: DEEP SPRINGS COLLEGE

Deep Springs College occupies an isolated valley 12 miles long by 5 miles, and hence has one of the nation's largest settings for a campus. The student body is limited by the college's charter of a maximum of 26 students, hence it is one of the country's smallest. Both verbal and mathematical Scholastic Aptitude Test (SAT) scores average near 720 respectively. This makes Deep Springs the second most selective college based upon these criteria. All students are on full academic scholarships (Lemons 1985).

PURPOSE

The stated purpose of Deep Springs is to prepare people for a life of courageous leadership and service to humanity. The educational philosophy is that the capacity for responsible action arises from the proper proportions of idealism, scholarship, and practical ability. The college attempts to rigorously, but not exclusively, develop the intellect. Development of character, responsibility, and physical and spiritual growth are also emphasised. Accordingly, the college attempts to educate the whole person. A goal is to strengthen character by scholarship as well as by real life stuggle with moral issues and economic necessity: students are thought to learn only if granted responsibility.

ACADEMIC PROGRAM

The academic program at Deep Springs is, by common consent of students, faculty, and outside accreditation teams, rigorous in form and content. Class size is generally three to five students and the Socratic method of teaching prevails. As at traditional colleges, classes include reading and research assignments, discussions, papers and grades. Classes meet during prescribed hours. However, many informal but serious discussions of class content occur outside of class. The curriculum is devoted entirely to the liberal arts; there is no relationship to agriculture or business. Examples of courses include, but are not limited to, chemistry, physics, biology, ecology, environmental studies, environmental ethics, linear algebra, calculus, Shakespeare, French, German, Greek drama, American cultural history, political theory, theories of social violence, nineteenth-century American literature, music theory, Beethoven, the eighteenth-century novel, poetry, and drama production. The only required courses are freshman composition and public speaking. Public speaking occurs weekly, and is attended by students, faculty, staff and family members. Topics range from international affairs to institutional concerns, and sessions provide a natural setting for the exchange of ideas and unification of the community.

SELF GOVERNANCE

Student body government demonstrates an integral part of the Deep Springs philosophy. The Deep Springs Deed of Trust legally defines the student body and three major student offices: (a) a student trustee who is a full voting member of the Board of Trustees; (b) a labour commissioner who is responsible for assigning and directing the labour of students in the work programme; and (c) a student president, who is the student body administrator and official liaison with the dean or college president. The powers, functions and procedures of student body government are not officially enumerated or restricted beyond their definitions in the Deed of Trust. However, the working interpretation of the Deed of Trust has always been that students are: (a) responsible for the conduct and evaluation of members; (b) responsible for selection of new students; (c) have significant input and responsibility for faculty hiring, faculty evaluation, and course offerings; and (d) have full control of student dormitories and ranch tools. Thus the basic power to control exists and it is the responsibility of each student body member to accept that power and use it wisely. The student body has only two fundamental rules. First, students do not use alcohol or non-medicinal drugs while in residence. Second, an isolation policy requires students to remain in the valley or adjacent wilderness while school is in session, unless an emergency occurs or they are given special permission to leave by the student body. The student body enforces these ground rules.

LABOUR PROGRAM

Taxing work of at least twenty hours per week is required of all students. The purpose of the work program is not for students to work off their scholarships or to primarily teach specific skills. Students are expected to do their work well, but also to gain a perspective and capacity for dealing with new situations that exceed thes kills learned for a specific task. Since the college is also a working ranch, students are involved in all aspects of producing crops and ranch stock; they also maintain the physical plant, run the bookstore, library and post office, and perform some administrative office functions. The college is, to a degree, self-contained and in some years realises a modest profit from raunching operations. Students are granted responsibility and the opportunity to learn from their mistakes. A failure of the students to respond, individually or collectively, to the demands of the work programme would jeopardize the college's tenuous financial base. Thus how students fulfil their responsibility is of paramount importance to the entire operation, maintenance, and fiscal health of the college.

THE DEEP SPRINGS EXPERIENCE

Although Deep Springs has extremely high academic standards, the uniqueness of the experience is the combined consequence of academics, governance and labour.

Because of the isolation policy, the organization of the college and its small size, the experiences of trying to live virtuously and of being a member of the community are very direct, intense, and participatory. As described by Schuman (1981), the Board of Trustees has de jure authority to act for the college. However, the board is obligated by the college's deed of trust to respect and comply with student sentiment; to this end, a student is a full voting member of the Board. The chief administrator of the college is the president, but presidential powers are nowhere made explicit. The deed of trust specifically gives the student body responsibility for "... the conduct of its own members." Faculty do not exist as a political or authoritative body as is traditional elsewhere, but can be influential depending upon their ability to persuade, and given their traditional pre-eminence in curriculum and academic affairs. To further confuse the issue, the alumni association can be a powerful force in institutional policy.

A consequence of this nebulous power structure is that nobody can arbitrarily pronounce on a public matter and then justify him/herself by virtue of a position of authority. This consequence, combined with the fact that students come to the college with some well entrenched ideals, which are further developed and reinforced by the intellectually demanding academic programme, affects both the content of the decisions made and the method of reaching them. Basically, the college's goals, structure, and function: (a) provide a rigorous academic programme which stresses content; (b) provide for the modification of taught ideals by personal experience; (c) demand participation in community, and the sharing of responsibility for making decisions that affect individuals, the community, the classroom and the entire institution; and (d) integrate the experiences of education, community and work. Accordingly, the Deep Springs model redresses major problems inherent in traditional approaches to the teaching of values, planned change, and specialized learning (Lemons 1985, Newell 1982).

EVALUATION OF LEADERSHIPS PROGRAMS

Evaluation of programs is crucial for both one's understanding of them in order to assess their success. The examples provided from the Sierra Project, Alverno College, the Cluster School, and Deep

Springs College have been extensively and positively evaluated (Whiteley and Loxley 1890, Earley 1980, Wasserman 1980, Lemons 1985).

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VOCATIONAL DEGREES IN ENVIRONMENTAL HEALTH

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INTRODUCTION

There are over 7,000 Environmental Health Officers in the U.K., concerned with both day-to-day problems of public health and with longer term strategic issues.

This paper is a review of (1) the development and philosophy of degrees for intending Environmental Health Officers in local government and (2) problems relating to the assessment of their professional competence. The development of these courses involves a creative tension between academic and professional requirements.

The World Health Organisation defines health as a state of complete physical, mental and social well-being and not merely the absence of disease or physical infirmity; and defines environmental health as the science of art of preventing diseases, prolonging life and promoting physical health and efficiency through organised community efforts for the control of the environment, control of the spread of infection and the identification and detection of those conditions which involve risk in the absence of intervention (WHO, 1980).

It is important to distinguish environmental health from individual health and personal care which are the concern of the clinical, medical, nursing, diagnostic and social welfare professions. They have numerous interfaces but in environmental health the level of control and involvement is population-based and preventative rather than individual-based and therapeutic.

In the United Kingdom responsiblity for environmental health resides in the main with local government authorities through their environmental health: law enforcement, monitoring and control, planning, advice and liaison. A problem facing environmental health officers in the United Kingdom is that their professional qualification has not until recently been of graduate status. It can be argued that this fact has militated against the acceptance of United Kingdom-style environmetnal health officers in other countries.

The historical development of concern for environmental health in the United Kingdom will be of particular interest to overseas delegates. The industrial revolution in the nineteenth century was associated with social revolution. Progress in material wealth and scientific and technological innovation was at the expense of much human suffering. Out of squalor and misery and awareness and knowledge of the relationship between pollution and public health developed. The government's acceptance of responsibility was manifested in legislation and the establishment of administrative frameworks and inspectorates to attempt to control environmental pollution and improve public health. Parallel developments occurred in many countries.

Environmental health work in the United Kingdom covers food and food hygiene; occupational health and safety, air and noise pollution housing standards; solid wastes; port health; pest control, and control of infectious diseases. Regional Water Authorities have responsibility for water pollution control.

These areas of work are diverse but the skills required and the duties undertaken are similar. There are many interrelationships and opportunities for beneficial integration, and the comprehensive approach avoids problems that would arise if environmental problems were viewed in isolation.

The current scope of environmental health work is the result of an ad hoc process (Morisetti and Kliger, 1977; Bickerdike, 1978) but the underlying rationale has been that as far as possible a community should control its own environment. Central Government has retained control of complex industrial processes and activities of strategic importance, but has otherwise delegated powers and responsibility to the lowest tier of elected local government.

The aggregation of duties and responsibilities at the same tier of government has, over a century, resulted in the development of the U.K. Environmental Health Service and the training of Environmental Health Officers reflects the present needs of the service.

Until 1974 an Act of Parliament had required Environmental Health Officers to work under the general direction of a Medical Officer and this suppressed both the development of the Environmental Health profession and the training and education of its personnel. Training was designed to produce competent Public Health Inspectors able to fulfill a variety of tasks within a local authority's powers and duties. Since 1974, as a result of: (a) changes in the status of Environmental Health Officers and release from their subordination to Medical Officers; (b) local government re-organisation; and (c) the advent of the European Economic community, the training and education, and the roles and responsibilities of Public Health Inspectors have changed. To reflect these changes they are now called Environmental Health Officers. Their roles and responsibilities have expanded to match the increasing problems of environmental pollution and public health, and academic standards have risen markedly. Polytechnics and universities have responded by developing degree courses in Environmental Health; and recognition of the growth and development of the Environmental Health service was demonstrated by the granting of a Royal Charter to the Institution of Environmental Health Officers in 1984.

In general, other countries in the Economic Community do not have a comparable comprehensively trained profession. The legal administrative background essential for comprehensive environmental health control is lacking, and there is no integrated service. The continental pattern is for highly qualified specialists to act as consultants for government authorities. Thus one can have a situation, as in Hamburg, where meat is controlled by Veterinary Officers, and other foods (including canned meat) by appropriate specialist University staff. Neither profession has a law enforcement responsibility. In France, environmental control is fragmented over several tiers of government and in Holland, food control (other than meat) is isolated from other environmental health problems and is the responsibility of of analysts and bacteriologists alone.

The Council of Europe Programme of Action of the European Committee on the Environment, adopted in 1973, and the large number of programmes developed over the years plus the entry of the U.K. into the E.E.C., have given fresh impetus to a rational approach to Environmental Health. The World Health Organisation has also commended a U.K. style comprehensively trained Environmental Health Officer of graduate status to Member States (WHO, 1978).

ENVIRONMENTAL HEALTH DEGREES

In the last ten years five new degree courses in environmental health have been introduced in the U.K.: Thames Polytechnic (1975), Leeds Polytechnic (1976), Bristol Polytechnic (1978), University of Ulster (1977) and Manchester Polytechnic (1980), augmenting established degrees at Aston, Salford and Strathclyde Universities. Regrettably, and inexplicably, the Aston and Bristol degrees have since closed but a B.Sc. Environmental Health started in 1984/85 at the University of Wales. This expansion of degree courses has been paralleled by a reduction in the number of Environmental Health Diploma courses (only two centres remain). Over three-quarters of the current entrants to the profession are from degree courses.

All United Kingdom environmental health degrees have common aims:

(a) to claify physical, chemical and biological interrelationships in the environment, by developing and applying an understanding of fundamental principles of the physical, chemical, biological and earth sciences;

(b) to develop an awareness and appreciation of man and his interaction with the environment both in the biological and social terms; and

(c) to elucidate values/parameters necessary for environmental management, by demonstrating:

  i) the contribution of science to the technologies which have developed to satisfy man's needs for water, food, shelter and waste treatment,

ii) the principles of public health administration and related laws, and

iii) the inter-relationships between environmental sciences, social-economic systems and legal and administrative processes.

The content of the environmental health degree courses reflects the practitioners needs to a greater or lesser extent. All are concerned with basic principles and concepts illustrated by reference to custom, practice and case studies relevant to environmental health work. All are sandwich courses, incorporating an element of professional training (which in the U.S.A. is called co-operative education).

PROFESSIONAL COMPETENCE VERSUS ACADEMIC RIGOUR - THE ORIGINS OF THE TENSIONS

Vocational commitment is important because environmental health is concerned with the integrated control and management of our environment. This means the complex interaction between scientific/technological controls and legislative/administative/fiducial controls contributing to pollution reduction and the maintenance of public health. Wider issues of resource exploitation are important in an academic context, but their immediate relevance to environmental health practitioners can be questioned. Not all workers would accept the academic validity of vocational commitment. Some scholars and researchers would prefer a purely academic approach, devoid of vocational commitment and possible professional bias, as an intellectual exercise in multi-disciplinary studies. However, attempting to evaluate and solve problems is also important, and has an intellectual rigour, a discipline and an educational value which more than justified a vocational commitment. For an alternative perception see paper by Cusack and Wood. (1985)

The present system for training environmental health officers in the U.K. assumes that competence is attained through a more-or-less standard curriculum which incorporates traditional education in basic environmental sciences, other appropriate disciplines contributing to environmental studies, and experiential professional training. All environmental health graduates and diplomates are considered in the eyes of the law to be professionally competent the day they graduate. A newly qualified B.Sc. Environmental Health graduate is an authorised officer. Hence the vocational pressure inherent in such courses. The tensions produced can be healthy and constructive. They can also be damaging and destructive.

It should be an intention of any vocational degree course to produce graduates potentially competent to practise their profession, and capable of contributing to the future development of their profession by enhancing knowledge and deepening understanding. It is important that considerations of professional and technical competence should not be confused with academic rigour and the development of intellectual skills. The award of a degree at its most basic is certificating the academic threshold and we would argue that professional competence is, in practice, a separate issue - albeit above this threshold.

Degree courses, because of their concern for sound conceptual bases, need to emphasise principles as much as practice. For vocational degrees such as environmental health, practical training may be integrated to a greater or lesser extent into the courses via professional training periods with local authorities, based on the well-established sandwich priciple. The current recession, and the inability of local authorities to fund enough trainees, may put pressure on colleges to offer full-time courses and eliminate professional training and experience, particularly if a requirement for a period of postgraduate experience is adopted by the profession. We would resist the introduction of full time degree courses in Environmental Health. There is a synergism in the integration of periods of practical training and experience in the programme of theoretical training which assists theoretical understanding, the development of professional maturity and powers of integration. Obviously thin sandwich courses with short periods of training have more to offer in this respect than the thick sandwich courses with on 12 month training period.

The academic philosophy of broad-based interdisciplinary studies is common to many environmental degree courses. What distinguishes environmental health is the need to train for the present as well as to educate for the future. The graduates are being educated and trained for work. There is little environmental health graduate unemployment and the demand for environmental health graduates to fulfil tasks in existing programmes of Local Authority work continues. So the tensions between academic and professional components of courses result from concern that the short-term interests of employers and graduates should not cause long-term problems in the career development, status and ethos of environmental health officers.

It is clear that there is a danger of a constrained view of environmental issues emerging if environmental health courses reflect only the current duties and responsiblities of Local Authorities. These have to be placed in a broader and non-vocational perspective, and, treated in a disciplined thematic form to develop fully the students intellectual and imaginative skills and powers. Increasing knowledge by itself is not sufficient. The primary objective of any degree programme is to stimulate thought. That environmental health courses can serve as a vehicle for such intellectual development should not be in doubt. However, the expectations of employers have to be realistic and all members of the profession must be perceptive and discriminating in their views on professional competence and the content of courses. The profession should not assume that all graduates with to enter local authority practice. There is an increasing market for Environmental Health graduates in commerce and industry and the proper development of Environmental Health as a discipline rather than as a profession necessitates the movement of significant numbers of graduates into research.

A view on environmental health education and training at degree level and its implications for the future has been given by Morisetti and Kliger (1977). Bickerdike (1978) has commented on professionalism and the way ahead, and on the academic respectability of the profession (Bickerdike, 1982). Professional competence and its assessment in environmetnal health have been reviewed by Caney, Kliger and Chambers (1983).

PROFESSIONAL COMPETENCE

There are very few professions prepared to award full professinal recognition on graduation, the usual requirement being for a period of additional professional experience. As long as the environmental health officer's profession wishes to operate a system of concurrent graduation and registration as professionally competent there will be a tension and a conflict of interests between practitioners and employers on the one hand and those who oversee education and training on the other. The environmental health officer's profession is by no means unique in this situation.

Dickinson, Dervitz and Media (1967) have defined a profession as an occupational group which provides a service considered essential to the public welfare and based on knowledge so specialised that the client is not an able judge of either what he needs or what he gets. Using this definition, for any profession, competence and its assessment are vital topics. In the interest of the public, who use the service of the profession, a minimum standard of competence must be determined and maintained. Such a standard usually starts with the cut-off point between pass and fail in end of course examinations.

Considerable attention is given in most courses to the assessment of theoretical knowledge and a rationale for this has to be provided for all Council for National Academic Awards degrees in the U.K. It is also in the interests of the professionals themselves to establish an identifiable standard of professional competence so that those who are admitted to the profession are acceptable as colleagues and so that a basis for professional advancement can be clearly defined. A clear definition of competence is therefore needed by both the public and the profession.

In 1979 the Council for Professions Supplementary to Medicine defined competence as the possession of the knowledge, skills and attitudes enabling an individual to perform fully in a basic professional role. It includes performance of tasks and relationships ..... which meet specific objectives of safety, effectiveness, efficiency and social acceptance in the environments normally encountered. (Higher Education Working Party Report, 1979). Clearly, competence demands demonstration of appropriate theoretical knowledge, satisfactory skill and acceptable attitudes. The student, apprentice or learner may be able to demonstrate an adequate standard of knowledge, perform the skills of the profession and exhibit approprite attitudes, yet still not be deemed competent by his assessor.

The standard required for competence is the ability to recognise, select and respond to cues quickly and appropriately. Competence involves theoretical knowledge; skill performance; and social skills, attitudes and behaviour (see figure 1). Professional competence, therefore, can be assessed by analysing and measuring these aspects objectively. A model of competence has been presented by Caney, Kliger and Chambers (1983), (figure 1). While analysis of this kind goes a long way towards standardising tests and making explicit what is required, wide variation remains in the competence of those who qualify.

Professional competence is more than the sum of its parts. Assessment of the integration achieved by the student will perhaps always remain intuitive and subjective. Of necessity assessment of integration can be done only be experienced members of the same profession who should themselves have achieved integration of the required knowledge, skills and attitude.

COMPETENCE IN ENVIRONMENTAL HEALTH

It is the integration of knowledge, skills and attitude which constitutes professional competence and for all professions this is an expanding continuum. Educators and the professions they serve have to agree on a quantifiable level of competence both for the award of a degree and, separately we believe, for entry to the profession.

The Environmental Health profession must first decide the extent and type of knowledge and skills seen as appropriate for different tiers of professional and technical employees. A professional profile must be produced.

The profession must agree on the criteria to be used and the appropriate level and method of assessment for purposes of registration. It is then necessary to establish priorities and the relative importance attached to these criteria. The following scale is based on Forster and Galley (1979).

Level 1	All or most of the agreed criteria to a consistently high degree, the remainder to an acceptable degree.
Level 2	A few of the criteria to a high degree, the remainder to an acceptable degree.
Level 3	All the criteria to an acceptable degree.
Level 4	Some of the criteria to an acceptable degree, weaknesses can be eliminated with experience and help.
Level 5	None of the criteria to an acceptable degree.

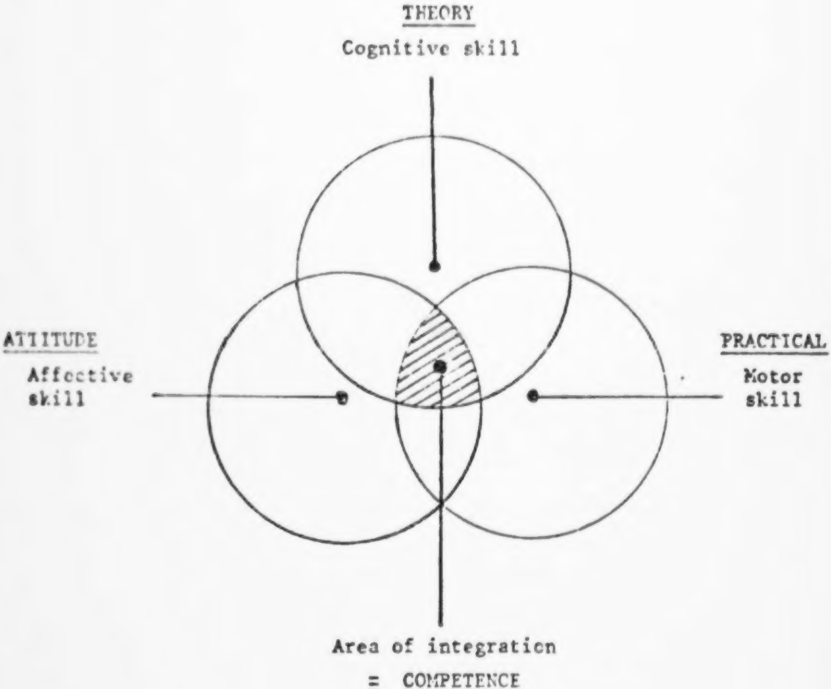
THEORY
Cognitive skill
ATTITUDE
Affective skill
PRACTICAL
Motor skill
Area of integration
≡ COMPETENCE

FIGURE 1 Skill Integration: A Model of Competence

The professional body has to decide the level at which it will confer recognition of full professional competence. Level 3 is the notional standard applied to all newly qualified environmental health graduates but in reality the standard would appear to be below this and closer to most of the criteria fulfilled to an acceptable degree. This statement is deliberately contentious. The realistic assumption which operates in practice is that on the award of a degree the candidate has demonstrated and partially realised a potential for professional competence with implied weaknesses either in knowledge, skills or attitude which can be eliminated given time and experience. We believe that professional competence should be certified when these weaknesses have been eliminated.

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THE DEVELOPMENT OF ENVIRONMENTAL HEALTH EDUCATION IN THE UNITED KINGDOM

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INTRODUCTION

It seems likely that the first organised concerns for environmental matters in the world occurred in Britain in the early 19th century. The twin motives of self protection from infection and humanitarian concerns about the appalling conditions under which the people were living were combined, and the government of the day became frightened into action. The response was diverse but one result was the passing of the Nuisance Removal and Disease Prevention Act 1846 quickly followed by the Public Health Act 1848. These Acts set up for the first time a comprehensive local government system, with local boards of health having powers to Act on environmental matters within their district area. The Acts also allowed the appointment, by the newly created authorities, of Medical Officers of Health and of Inspectors of Nuisances (Lumley's Public Health, 1930). These latter officers were required, as a pair of working hands, for the Medical Officer of Health.

These "fit and proper persons" were not initially required to hold any qualifications. In 1877 The Sanitary Institute, later the Royal Sanitary Institute, and now the Royal Society of Health, instituted courses of lectures and held examinations leading to certificates for inspectors of nuisances and sanitary inspectors, both designations being current by this time (Clay, 1961).

The Public Health (London) Act 1891 was the first to set a statutory requirement that sanitary inspectors should be holders of a certificate of competence approved by the Ministry of Health. In 1899 the Sanitary Inspectors Examination Board was set up in spite of serious objections, particularly from practising officers who had no representation upon the Board. The Board was in fact made up of representatives or the guilds of Plumbers, Carpenters, Architects, Engineers and Medical Officers of Health, in addition to members from the Local Government Board, the Sanitary Institute and National Health Society. They instituted examinations and, in order to take this examination, candidates had to have satisfactory training equivalent to three years full-time experience as a sanitary inspector. A new joint board was set up in 1926 for the purpose of qualification as a Sanitary Inspector under the various statutes, which, by then, required their appointment by every local authority. Emphasis throughout these years was upon practical experience with qualifying examinations which could be taken, by experienced officers after preparing for them whilst working full-time. There was no academic basis for the studies which these officers undertook, rather they learned the basic techniques of other disciplines such as building and sanitation related to the gross offences against health, which were being widely committed at the time and which were listed in statute. Practical experience has continued to be the key note of qualification in this profession up to the present.

The Diploma scheme, introduced in 1960, was described as a four year course of full-time practical training under a system of paid pupillage with local authorities (Public Health Inspectors Education Board (1961)).

This system made the responsibilities of the employing local authorities one of training, rather than education and gave then full powers to appoint pupils and to send them to whichever college course they wished. This resulted in a large number of courses around the country each with local support. These Diploma courses were specially designed to suit the Sanitary Inspector/Public Health inspector training requirements and in no way complied with nor fitted into the further education or higher education system of the country. They were based upon the received wisdom of other disciplines often at an elementary level.

Since 1974 when the title was changed to Environmental Health Officer (EHO) the Diploma courses have continued to include elementary material from other disciplines plus knowledge gained from colleagues at work. Knowledge gained in this way has serious shortcomings: there is no test of the quality of the information gained, its accuracy or appropriateness. The pupil cannot be expected to confirm the information; having no basis upon which to judge. Much of this knowledge may be anecdotal/appochryphal and there is seldom any possibility of feedback to ascertain if everybody is telling the same story. Further, a course of training which emphasises this method cannot be expected to be innovative or to move the profession away from a simple reaction to environmental circumstances. New knowledge and novel methods are unlikely to be introduced.

A working party report (Ministry of Health, 1953) mentioned the possibility of a university degree in sanitation or sanitary science and the first degree courses for public health inspectors began at Aston and Salford Universities in the ealy 1960's.

For the first time the content of environmental courses was subject to academic scrutiny. For different reasons neither the structure nor the content of these courses was the result of fundamental research into the nature of environmental health. In both institutions the lists of diverse subjects such as, refuse control, hygiene of buildings and housing were accepted as sacred and established syllabuses were merely placed into the setting of a degree course with the academic rigor placed elsewhere in the structure. In neither was a chair of environmental health or separate department set up, and neither higher degrees nor research degrees were introduced until much later. The courses developed were not studies of disciplines such as sanitary science: they were merely degree courses for public health inspectors.

The introduction of Polytechnic and of CNAA Degrees gave an opportunity for some fundamental thinking about the nature of the subject to be studied as Environmental Health. However, the Department of Education and Science could contemplate these new courses only as replacements for the preceding diplomas; and in their view the courses had to have principally professional objectives. No new courses were allowed which would convert existing professional courses into discipline-based study courses.

Unfortunately, the Environmental Studies Board of the CNAA felt unable to judge new courses purely on academic grounds. They introduced to evaluating panels senior members of the professional organisation - to ensure that professional objectives were not overlooked. However, the true effect was to prevent new views of environmental health from emerging and to plant a substantial component of the old technical studies in the middle of nicely prepared discipline-based schemes - thus overbalancing their academic structure. The remainder of the CNAA panels and the Environmental Studies Board overall, were unwilling or perhaps powerless to resist these impositions. This has resulted in courses with overburdened syllabuses and has led to conflict amongst academic staff about the priorities to be applied in teaching and assessment. Any sandwich element had to involve a period of at least 12 months professional experience with a local authority. Practising Officers regarded this as a minimum period of practical training and it is still regarded as insufficient by the Institute of Environmental Health Officers (personal communications). Attempts to allow this period to be spent with another type of employer, or in another country, have failed because the professional body has threatened to refuse to register any such student for professional membership on graduation.

Students on the courses have determined their own priorities - assuming that the preparation for a professional career was paramount. Recruitment has, therefore, tended towards attracting those who chose an EHO career rather than encouraging those who found the subject stimulating and worthy of further study. The question of the relevance of material on the courses has been a constant problems. Subjects like meat inspection have had to take precedence over many other aspects of the syllabus because the Professional Registration Board insisted upon this. Conversely studies of world food supplies for example, have had to be curtailed, because they are of questionable relevance to the practising EHO.

There is no doubt that good strong honours degree courses have been built up based upon a compromise between the conflicting elements of professional and academic objectives. Environmental health education is now well established and the preparations for a career as an EHO are now vastly superior to those of the past. It has, however, taken over a hundred years to reach this position and the discipline of environmental health has still to be established in Britain. Research is minimal and there are no higher degree courses specifically in environmental health. The courses still deal in material forced by the current circumstances than any predictive modelling or hypothesis testing. The profession is usually seen as having a lowly status and many would ask whether or not it fits the definitions of "Profession" usually used. Reasons why it has taken so long to achieve so little include: (1) the limited educational provision; (2) the nature of the subject; (3) legal barriers to development specially those relating to ultra vires in local government in which most EHO's are employed and (4) inertia and bureaucracy of local government employment.

No body of knowledge has been established which can be specifically identified as environmental health. In addition the material which is published is usually the result of one officers experience rather than resulting from a body of knowledge based on research, development and testing. This means that the information contained may have no universal application, is unrefereed and may not be in a form useful for teaching purposes. For example, new discoveries in science often allow students to repeat the formulating experiments and tests for themselves in the laboratory. This is not possible as far as most environmental health "findings" are concerned.

There have been very few learned texts which deal with environmental health issues. Those upon which reliance is made are either by authors of other disciplines or concentrate upon technical information originally produced by others. There have been no publications concerned with the philosophy or ethics of environmental health actions and few where the methodology of the profession is codified and critically discussed.

These and other shortcomings of the educational provision have meant that members of the profession have in the past not been introduced to environmental health as a recognised academic subject and accordingly their studies have not been academic. It is not surprising, therefore that practising officers are unable to see their professional work in these terms.

Environmental health is made up of many diverse strands and no unifying theory has so far been enunciated. Topics such as food, housing, pollution and occupational hygiene, have little in common and in-depth knowledge and understanding of one gives little help in the study of the others. This diversity of subject has also prevented the development of real expertise at the frontiers of knowledge. An environmental health officer is unlikely to be the leading authority on anything. The constraints put upon his learning and reputation are sufficient to exclude him from consideration when new problems arise. For example, when cases of legionnaires disease were identified there were many experts called in, viz medical engineering, microbiological, to survey hotels etc, to determine the cause of the outbreaks. Environmental health officers were not included yet legionnaires disease presents a classic environmental health problem.

Every aspect of the subject of environmental health exists in the sphere of another discipline or profession. Whilst there may be a unique blend of extracts from these several spheres which may be identified and defined as environmental health, no one has so far delineated the boundaries. The result is that the solution of any complex or advanced environmental health problem usually lies within the frontiers of another discipline.

Unless the EHO is schooled in that discipline his efforts will always be seen as elementary within that particular science. It is impossible for the EHO to be schooled in all those disciplines which may touch upon environmental health work and he will always have to rely upon other experts for solutions to most of his problems.

Legal barriers to the development of the profession, and the inertia and bureaucracy of local government are outside the scope of this paper.

CONCLUSIONS

Sanitary inspectors were right to criticise and distrust the examination system imposed upon them by others in the early part of this century. Their opposition resulted in improvements in training but had done little to alleviate the real problem - the inadequacy of the existing educational base. The lack of educational imperitives and the emphasis on training requirements has stultified the development of environmental health in its own right and has served to maintain the lowly status of both the officer and the subject area in the United Kingdom.

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ENVIRONMENTAL HEALTH AS A DISCIPLINE IN HIGHER EDUCATION, WITH PARTICULAR REFERENCE TO BRISTOL POLYTECHNIC

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In a previous paper (Cusack and Wood, 1985) attention was drawn to the inadequacy of the academic/educational system provided for environmental health during the earlier parts of this century, and to the consequent lowly status of the subject today. One of the underlying causes of this state of affairs is the lack of any acceptable definition which delineates environmental health concerns from those of other professions. There is not even an agreed core of the subject which is indisputably identified as environmental health territory and lists of topics which are commonly included under the heading of environmental health in countries around the World fail to distinguish between the matters which should be regarded as central concerns and those which are peripheral. They also are useless when new problems arise which have not been listed.

There is no strong worldwide organisation of environmental health because each country, whilst requiring the same safeguards of public health, has developed its own mechanisms to achieve this. The diversity of personnel makes international exchanges of views and information unlikely, and whilst international conferences have been held since the turn of the centry, they have been small scale and have had little impact.

In the USA and some other countries environmental health has developed beyond the confines of a central or local government agency job and into an academic subject worthy of study and research in its own right. Universities offer programmes of study leading to higher degrees in environmental health, often linked to post graduate faculties of medicine. These educational and scientific initiatives are separate from training courses provided by the state for sanitarians and othe professional practioners. Without an acceptable and agreed definition of environmental health there will be no subject recognised as such and no meeting of like minds worldwide.

It became obvious in the UK in the early 1970's that environmental health must develop beyond the objectives of the diploma course, i.e. training for the job as it was then described. It was perceived that the new degree courses being prepared for approval by the CNAA would need to have a strong academic base with a logical progression of knowledge and skills developed by the study of appropriate environmental health subjects. This was seen to contrast with the unrelated studies of the diploma course curriculum. The courses would also need to prepare students to understand the new problems likely to arise over the coming decades rather than teaching solutions to problems already dealt with. The subjects included would have to be defined and chosen not as in the past, because they had always formed a part of public health studies e.g. refuse control, water supply, sewage disposal, but rather according to their role in achieving an understanding of man's physical environment and the relationship it has with human health.

Instead of an ever growing mass of technical information forming the core of the studies it was essential to distil out an unchanging essence of the contributing subjects so that students were given an understanding sufficient to enable them to find the detailed information they were going to need in future. By this means, it was argued, students would be able to deal with the unknown problems of the future.

At Bristol in the early 1970's first attempts at reviewing future developments in environmental health led to the conclusion that a full time course of study into the new discipline of environmental health was needed. The course would centre on the relationship between environment and health, and whilst the work of the environmental health officer would be studied in this content it was not to be central nor constrain the limits of the course. The perspective adopted was looking outward from the human body towards the physical environment with emphasis upon the reactions 'out there' rather than those within the body. By this means a definition of environmental health was achieved and used in curriculum development. Our proposal, although it has some raw edges, was new and urgently needed in the UK but the response of the Council for National Academic Awards (CNAA) panel set up to consider the proposal, at their first exploratory meeting, was entirely hostile. It was made plain that only a course which contained the essential training for the job of Environmental Health Officer (EHO) would be considered. The proposal had to be modified to include a sandwich period of one year, training in such skills as meat inspection, poultry inspection, housing surveys and many of the other daily tasks which engaged the professionals at that time. Similar reactions were apparent when the other Polytechnics put forward their first proposals for Environmental Health Degree Courses.

An amended course proposal was prepared, based upon an analysis of the activities of environmental practitioners. This still contained many of the Environmental Health discipline ideas of the earlier versions but, because of the constraints of time, there had to be compromised to some extent. The new course was approved by CNAA only after the Environmental Health profession members of the panel had insisted upon the introduction of specific subjects called Housing and Professional Practice.

Inspite of the declared policy of the Institution of Environmental Health Officers of aiming at an all graduate profession, the reaction of members of the profession both locally and nationally to these new CNAA degree courses was invariably cool. Members of the profession without degrees saw the potential influx of graduates as a threat to their position and there was scepticism about the lack of 'preparation for the job' in these new courses. The course at Bristol Polytechnic was singled out for special criticism because it did not adhere to the policy of paid pupillage or sponsoring prior to admission which the other courses continued. In fact sponsored entry has been rejected at Bristol because of the limitations it imposed on the selection of students by the college and the consequent bias which this was known to introduce. This meant in fact that for the first time employers did not have complete control over all entries to the profession. The numbers entering the course were decided by the Polytechnic according to considerations of funding and resources and with an eye to economies of scale. This too met with the disapproval of certain members of the profession who were concerned about the over production of EHOs.

The sandwich year placing of students thus became the responsibility of the college, although some resistance to taking Bristol students was encountered mainly in the London area. Nevertheless professional experience of an appropriate quality has been found for all students. 230 students have been placed to date and ironically each year there have been more places than students available to fill them. In contrast with the Diploma courses and the other degree courses a great deal of time and resources have gone into the supervision of these students on placements. All students are visited at least once a term and a series of objectives to be achieved are agreed with the employers. The achievement of these objectives is measured by a series of assessed assignments and accordingly the workload on the students is considerable. Supervision ensures that the employer provides a proper programme of experience and encourages their involvement in the course and its assessment.

By 1982 there was three university and four polytechnic degree courses in environmental health in the UK with a further new course in Wales expected in 1984. Provisions seemed set fair from the advancement of the profession to an all graduate status in accordance with the declared policy of the professional body. There was also ample provision to ensure the development of environmental health into a recognised academic discipline worthy of study in its own right.

Centres of excellence were emerging in institutions where there had been substantial investment in the academic development of staff and in the physical resources of buildings and sophisticated equipment. It appeared that the five remaining diploma courses would be phased out due to dwindling support by LAs and a process of evolution was all that was required, rather than official action to see their demise. However, in September 1982 the National Advisory Body for higher education in the public sector (NAB) was set up and instigated a review of certain courses linked to the public sector through local government. Initially their brief, as far as environmental health was concerned was to rationalise undersubscribed courses (i.e. diploma courses). The intake to the degree courses was generally satisfactory and in fact the course at Bristol was oversubscribed.

Evidence gathered by NAB, principally from a survey of projected retirements from LA service of EHO over the next five years (Institute of Environmental Health, 1982) showed that there was considerable over provision of places on EH courses. It predicted that only 150 new recruits were needed annually. In the eyes of NAB the need for rationalisation was thus clearly demonstrated. At the same time the views of local government employers organisations was sought on the replacement of the diploma course by creating places on the degree course. However the Association of Metropolitan Authorities and the National Joint Council for Local Authority Services both urged the retention of the diploma and praised the efforts of the diploma course staff at Tottenham Technical College. They argued that no case has been established for upgrading EHO training to degree level other than to increase the status and accordingly the pay expectations of such staff. Such statement instance the attitude of the employers to matters of quality in environmetnal health.

In August 1983 NAB announced that their advice to the Secretary of State included the closure of the Bristol degree course on the grounds of over-provision of degree places. It was stated quite categorically that the decision was in now way a reflection on the quality of provision at Bristol. It was apparent, however, that as Bristol has by far the largest number of degree students the closure would have the most dramatic effect on the number of graduates entering Environmental Health. The decision was confirmed by Sir Keith Joseph in December 1983. At the same time cuts in financial provision at Aston University forced the closure of its degree course in Environmental Health.

At no time during this cost cutting exercise was Environmental Health considered to be a subject or discipline attractive to study and research for its own sake. Nor was potential for the employment of the graduates from such courses outside the sphere of local government investigated. All the decisions were based upon the assumption that the courses were training courses for EHOs and could operate only as such. If the NAB review had been conducted differently then provision would have been made for future developments, including provision for a suitable proportion of graduates to engage in full time environmental health research. The fetters of training for a job would have been released at least in part thus requiring the profession to set up a supportive profession at technician grade to enable the fully qualified Environmental Health Officer to operate in a truly professional manner. Although this would have required some difficult decisions of would nevertheless have resulted in higher standards of service at the local authority level and greater academic achievement in the universities and polytechnics. A unifying theoryfor environmental health could have been established and the learned texts of philosophy and ethics published. The whole subject could then have come out of isolation and taken up its rightful place in the field of environmental science.

The outcome of the NAB decision presents a very bleak picture indeed. In 1987 there will be two diploma courses remaining alongside the reduced number of degree courses in environmental health. The numbers of places on all the courses will be restricted and in the public sector institutions this has been limited to 27 maximum per year. An acute shortage of places has already arisen, particularly at degree level. This is because individual LAs, in spite of the evidence given by their national associations and quoted above, prefer their sponsored students to attend degree courses as opposed to diploma courses. Consequently all the degree course places are filled with sponsored students and no direct applications may be considered. The result is that all future entrants must be intent upon a local government career as EHOs, placing the control of recruitment clearly in the hands of the profession. The power to change the courses to a purely training mode away from their academic roots has already become apparent and in London for example, the course has been 'restyled' to more nearly match the professional requirements. When the educational provisions for Environmental Health have been entirely in the hands of the practising professionals training relevant to the day to day tasks has been the dominant feature with an over-emphasis upon practice and experience. This situation quite clearly constitutes a threat to the academic status of Environmental Health and also places severe restrictions on the ability of the EHO profession to monitor and control those factors in the environment that constitute a risk to health. Surely this is a matter of grave concern for the nation as a whole. Accordingly government must recognise the dangers inherent in the situation and act accordingly to rectify the lack of educational provision at the highest level for this most significant aspect of preventive medicine.

The professional institute, through its educational committees, must also provide the enlightened leadership of which it is clearly capable to arrest this trend which, in its most extreme form, constitutes a threat to its very existance as a body that stands comparison with other professional institutions.

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COURSES FOR ENVIRONMENTAL TECHNICIANS

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INTRODUCTION

Following increasing public concern about the environment, the need for well qualified environmental technicians has been widely recognised (UNESCO, 1978; Hughes-Evans & Harvey, 1979; Hughes-Evans & Potter, 1980; Potter, 1985). This concern has also influenced and increased the amount of Government legislation in the United Kingdom (Potter, 1979; 1981).

Studies of the environmental impacts of pollution have, however, been hampered by a lack of comprehensive monitoring systems and appropriate technical support. For example, measurement of smoke and sulphur dioxide pollution in the United Kingdom depends on a network of unevenly distributed monitoring stations (Keddie, et al, 1984). Similarly, a recent Government report on the emotive subject of acid rain states that no quantifiable evidence is available because of lack of monitoring (House of Commons, 1984).

A COLLEGE RESPONSE

In spite of the need for monitoring, no specialised environmental science technicians were being trained in the United Kingdom until a Business and Technician Education Council (BTEC) Higher National Diploma (HND) in Environmental Analysis and Monitoring was started at Farnborough College of Technology in 1981. The course was established after extensive consultation and liaison both with industry and monitoring agencies, and its aims, structure and success, have been described by Rees (1982).

The course, and subsequently established BTEC HND courses in Conservation Management and Energy Management, each include periods of industrial training - upon which twenty per cent of the final assessment mark of each student is based. Although primarily included for its educational value, the training assists many of the students to obtain permanent employment. Of the 50 Environmental Analysis and Monitoring students who had qualified by 1985, 20 took up employment with the employer who provided such training, 16 with a different environmental concern, and 14 continued their studies in higher education.

The Conservation Management course started in 1984, to train technicians for ecological surveys, ecosystem management and resource monitoring (Potter, 1985). Both multi-disciplinary and interdisciplinary, the course prepares technicians for careers requiring an understanding of the ecological concepts and technical principles needed for managing fragile and protected areas, sites of special scientific interest and regions ecologically at risk. The course includes the following units of study: Ecology, Conservation, Environmental Geology, Wildlife Management, Environmental Chemistry, Environmental Awareness, Geomorphology, Land Use, Management of Volunteer Groups, Ecosystem Damage, Resource Economics, Applied Computer and Statistical Techniques together with both Laboratory and Field Techniques. In addition, each student performs at least one ecological survey during a training period with a conservation organisation.

Energy efficiency is a matter of increasing importance, and in the United Kingdom energy saving is encouraged by Government support. In 1985, Farnborough initiated the first HND course in Energy Management - to train technicians to possess an understanding of the fundamental principles of energy, its production, its cost and its conservation, particularly as related to the built environment. The provision of this latest course is part of a process which is essential to both the United Kingdom and its environment.

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CONSERVATION : THE BASIS FOR ENVIRONMENTAL EDUCATION

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INTRODUCTION

An early impetus to environmental education was given by Sir Patrick Geddes (1854-1932), biologist, town planner and educator, who stressed the importance of multidisciplinarity, synopsis and synthesis. Since then, the Scottish Environmental Education Council has continued to review progress in environmental education and to refine its objectives. In the opinion of the writer, gained by experience outside the formal education sector, too little concern has been given to the establishment of an everyday conservation ethic.

THE IMPORTANCE OF A CONSERVATION ETHIC

Environmental education claims many worthy objectives but without an acknowledgement that our quality of life will continue to deteriorate unless each of us has a greater grasp of conservation principles, environmental education is arguably inappropriately named.

What continuity of experience is there at the movement from primary to secondary to tertiary education? How are we ensuring that changing patterns of work and leisure are reflected in opportunities for all sections to do something about the environment? How can we convert the boundless energy of some members of society towards the challenging of improving rather than vandalising our environment? Higher Education cannot be considered in vacuo and needs to encompass primary, secondary or even community education.

COMMUNITY CONSERVATION EDUCATION

The Countryside Commission for Scotland interprets conservation education as the process by which people's awareness of the countryside is heightened and by which a desire to conserve scenic heritage is fostered.

Conservation generally and usually implies the wise use of resources. Conservation educators, it can be argued, are trying to lay the foundations of a wise use of resources by each member of society, and are trying to build in love and care for the environment - not as a political expedient, not as a scientific hypothesis, nor even as a Country Code message, but as an attitude of mind. If we are educating for the environment as well as about it more of us must include an understanding of conservation matters as a prime objective of teaching. One way the Commission seeks to achieve this goal is through 'interpretation'.

INTERPRETATION IN CONSERVATION EDUCATION

Interpretation is described by Freeman Tilden as an educational activity which aims to reveal meanings and relationships through the use of original objects, by first-hand experience and by illustrative media, rather than simply to communicate factual information. Interpretation thus helps us to gain a greater understanding and appreciation of the environment in an enjoyable way. In my interpretivework with the Countryside Commission for Scotland I always try to think of it as a three stage operation; *information* presented in such a way as to cause *motivation* and through motivation *activation* on the part of the individual. The basic ingredient of interpretation is inter-relationships. The building blocks are individual sites which, after a process of selection, build into a regional interpretive strategy. The tools of the interpreter involve a basic understanding of inter-relationships together with imponderables such as aesthetics and emotional response. The interpreter seeks to provide people with the opportunity to reach rational decisions with regard to their environment. It also takes account of the fact that people need to feel a part of the planning process, that their opinions are important, and that they have a significant role to play in the nature of things.

But how can this be done? Is subjecting a person to a good dose of Environmental Education incorporating the points I have already outlined, the panacea of environmental ills? If it is our objective to do just this, how can we attain our goal?

There is a view that immersion in Environmental Education is not only essential to the solving of environmental ills, but is also necessary for each and every one of us to satisfy a basic biological and physiological requirement. An example of this kind of involvement is primarily concerned not with the conservation of an individual species like a bird or a flower, but with the wise use of a landscape, perhaps an urban derelict area. One of the suggestions made from time to time is for a resource centre situated closer to the local community, housed for example in a museum, a visitor centre, where the community council meets, or someone's back room - where the community has the necessary data available to them, and where a local conservation strategy could be worked out, updated and otherwise modified, and where decisions would be made to perhaps approve or object to a planning application, and where applications for grant assistance could be made to either public or private grant awarding bodies. Without public support for Environmental Education, and without a conservation ethic running clearly through our proposals, nothing will be achieved.

THE ROLE OF THE PLANNER IN ENVIRONMENTAL EDUCATION

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INTRODUCTION

Planners in England and Wales working under the system created by the 1947 Town and Country Planning Act and trained in a variety of backgrounds (including geography, ecology, architecture and engineering) traditionally deal with a range of functions relating to environmental control and management. These include: the identification of local town planning problems, preparation of countryside and urban improvement programmes, conservation of the natural environment, preservation of historic buildings and the encouragement and direction of manufacturing and business uses.

However, in the last two decades important shifts of emphasis have emerged by which less time has been devoted to major redevelopments and more to involvement with communities and their environmental problems. The development of an environmental education service within the planning profession is one indication of this shift of emphasis.

PLANNING AND THE ENVIRONMENTAL EDUCATION SERVICE

The Royal Town Planning Institute (1985) report on Planners and Environmental Education lists 160 in at least 100 local authorities in the UK who are active in the service. The main centres of this planning activity are London, Tyneside, Bristol and Winchester.

The work of these Planners covers varied topics, presented to children, pupils, students and adults. The activities include: local plan participation by school children, an award scheme to encourage children of all ages, preparation and implementation of village improvement schemes, rural studies, development of urban study centres, increasing the urban social skills of slow learners, day conferences for teachers and planners and open days for children at Planning Departments. Planners have also been involved in curriculum development, as well as devising many one-off, day-to-day projects, tailor-made from current issues for a specific education purpose.

In this way, by participating in formal and informal educational situations Planners are able to help children and adults to understand how their environment has been shaped, how it can be changed, and what part people can play in influencing its future. Familiarity with the basic information and understanding involved in the decision-making of Environmental Planning can help members of society to play their part in the process. Improved awareness through experience of real issues will increase the chances of society achieving and sustaining high quality in its urban and rural physical environment (RTPI, 1978).

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STUDY SERVICE AT COVENTRY POLYTECHNIC

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Study service is a form of work experience, organised as part of course work in many institutions of higher education in the United Kingdom (Whitley, 1890 and 1982). In the Study Service Project at Coventry Polytechnic must students cooperate with local authorities or health authorities, or with local voluntary groups. The Polytechnic also cooperates with the national volunteer agency Community Service Volunteers; and is funded by the Leverhulme Trust and the Gulbenkian Foundation.

Projects undertaken between 1984 and 1986, related to environmental studies, include: (1) monitoring pollution levels in a watercourse, (2) surveys of the use of sports facilities, (3) an energy audit in a school, and (4) design of reclamation and after-use of a coal tipping site. Students from many departments have been involved.

The work of organising teams involves mounting projects, securing commissions from customers, providing liaison and other back-up facilities, and evaluating the effects of the service - including how students benefit and the effects on academic staff and customer organisations.

Supervising Study Service projects often involves members of academic staff with the customer. Setting up the project requires agreement on mutually acceptable aims and on a programme of work. In the Polytechnic the initiative in setting up the project (or converting a proposal from a customer into a worthwhile project) may come from the staff member or from the student, or may be handled in more complex ways. For example, after discussions with the supervisor, the student may put forward draft aims and proposals to the customer. During the project, and in winding it up, the student is likely to have dealings with the customer organisation. Again the academic may have a role in aiding the student in these dealings.

In some projects customers are seeking knowledge and skills that are not available in their own organisation (see Richardson, 1983). The fact that service if free, or limited in its cost, is a further attraction. Customers also appreciate the enthusiasm and commitment of students, and the introduction of different viewpoints into their organisation.

With larger employers some projects come from central management but responsibility for supervision is always given to one person, so that confidential matters can be dealt with appropriately to the student's project fitted into the work of the organisation.

Some projects broadened a student's knowledge, others allowed a study of an aspect of the subject in greater depth that is possible in the classroom. And for many students project work increased their awareness of employment opportunities, made them more employable and helped in their choice of career. They also benefited from the experience of developing their own programme of work with the customer organisation, and with the guidance of their tutor.

The complex social problems that arise in relation to road building and mineral resource exploitation are discussed by Schon (1983) and Blowers (1980) respectively. Study service, in addition to helping students acquire skills helps them to develop their ability to use their knowledge and skills in tackling problems, and they see their work in relation to the work of other specialists and to the needs of society.

The expecations and experiences of students have been studies in relation to seven propositions about study service (Table 1) by asking selected students to complete a questionnaire before and after their project. Table 1 also shows how each proposition is likely to be affected by independent variables related to the student and the project. This attempt at quantitative analysis is supplemented by interviews with students to explore their thoughts on the value of higher education, their course in relation to their career, and the value of study service.

An example from 10 final year (fifth year) undergraduate students in town planning illustrates the approach adopted in identifying the effects of study service. All had spent their fourth year in professional training with planning authorities. The final year comprised two compulsory courses, one on current developments in town planning and the other on the role of planning in society, and two option courses in specialist areas of planning. In addition there was a short course in professional practice and a major project.

These 10 students, academic staff and some representatives of customer organisations were interviewed and the effects of study service on the students assessed by tests and questionnaires. Students were uncertain about what the project experience would add to their knowledge and employment opportunities and to the likelihood of their obtaining employment. This is surprising as many said anecdotally that they may choose a topic or client so as to enhance their employability. It may be that in parallel with the project they learn more about employment opportunities from papers and journals and from job applications and interviews than from the project itself.

Some students saw the experienced gained in one project as being of marketable value to a wide range of prospective employers. Others saw value in the likely attractiveness to a prospective employer of having worked with a particular customer organisation. Indeed, many students placed more emphasis on the customer's assessment of their work than on their supervisor's assessment.

Students differed in the relationship they saw between their projects and the subjects studied. For some the project was seen as supplementing the subject they were taking but for others it provided an opportunity to pursue one aspect of their subject in greater depth.

Most students select a topic which draws on knowledge and skills they already have rather than one which is fresh to them. Perhaps this choice is related to the way they relate the project choice to future employability. Most students felt they had learnt less than they had expected about the latest developments in planning practice, the ways large organisations behave, and about other people's expectations about planning. However, at the outset they had not placed much emphasis on these points and this is consistent with their conservative strategy in project selection.

Because the final year course emphasises forms of professional relationship and their appraisal, questioning was directed to the management of the projects. An important objective is the learning of project management and the responsibilities to clients and others. Students' initially high expectations of improving their skills of report writing, making verbal presentations and debating through discussions were generally not met. They found the demands of the customer organisations were not excessive and did not compete too much with other claims on their time. They felt themselves to be in control of the development of their own work programme with the customer.

In relation to environmental education, study service in all subjects increases the student's perception of the role of his or her knowledge and skills in society - and is part of the changing response.

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Table 1 Expectations about the Variables Influencing the Impact of Study Service on Students

Variables Influencing Achievement of Propositions

Proposition about Study Service	Student:			Course:		Project			Customer Contact
	age	sex	prior work experience	stage	career focus	individual or group	length	assessment	
1. Enhances Career Prospects	Y	Women	No	Early	Wide	Individual	nr	nr	Yes
2. Improves Management Skills	Y	nr	Yes	Early	nr	Group	Long	r	Yes
3. Reinforces Knowledge Appreciation of its use	O	nr	No	Late	Wide	Individual	nr	nr	nr
4. Adds Fresh Knowledge	Y	nr	nr	Early	nr	Individual	Long	r	nr
5. Has Educational Objectives	nr	nr	nr	nr	Narrow	Group	nr	r	No
6. Improves Social Skills	Y	nr	Yes	Early	nr	Group	Long	r	Yes
7. Contribute to Community Well-Being	O	nr	Yes	Early	Wide	Individual	Long	nr	Yes

nr = not relevant
r = relevant

A COMMUNITY-BASED MODEL FOR EDUCATIONAL INNOVATION

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A one year feasibility study entitled the "Community Science Project" funded by the U.S. National Science Foundations was initiated by the Smithsonian Office of Education Research in 1986. It involves the development of a model for the effective and efficient use of a community's resources and has broad applications for education at many levels and in a variety of disciplines.

The U.S. crisis in science education is part of a larger crisis in education: it is a community problem requiring a community solution. Similarly, the quality of environmental education and the ability of citizens to deal with environmental issues are not to be improved by schools and higher education alone. Four requirements can be identified, if educators are to make an impact on society, namely:

1) The need to educate the whole community, adults as well as children of school age.

2) The need to establish links between community sectors so that experience and resources can be shared, thereby enabling the design of a "tapestry rather than a patchwork quilt" (Denman, 1986).

3) The need to involve all citizens, adults and school children by linking environmental education with life beyond school. (Voelker, 1982; Goodlad, 1984) and using community resources.

4) The need for commitment and active involvement in learning about and taking responsibility for the environment.

We have established two-interactions, like the bartering system Naisbitt (1982) alludes to in Megatrends. Our goal is to develop a model that exploits under-used community resources by providing a system of communication and equitable exchange between sectors. A citizen involved in our project not only stands to gain benefits, be they education or otherwise, but is also required to contribute some resource. This notion has broad implications for environmental educators frustrated by apathetic citizens unwilling to be involved. The proper motivational structure exists when to get something they want, citizens must do something in exchange.

By expanding the concept of education to include as active participants not only the school, but the general public, the informal education sector, and industry, the under-use of resources in the community can be reversed and cost-effective, non-altruistic interactions established.

After choosing a school with a heterogeneous mix of students, and a high level of teacher, administrator and parental concern and involvement, we met representatives of organisations in the community, identifying their needs and the resources they could contribute, and establishing links between them.

We hope that the programme will:-

1) Be continued and become self-sustaining because all concerned appreciate its short and long term benefits, and

2) Provide a model that could be used in any community to the benefit of all concerned.

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